ADVANCED MECHANICAL DRAWING

INTERNATIONAL
TEXTBOOK COMPANY
SCRANTON, PA.

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Advanced Mechanical Drawing

BOOK II

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ADVANCED MECHANICAL DRAWING

Part 2

214B

Published by

INTERNATIONAL TEXTBOOK COMPANY

SCRANTON, PA.

Printed in U. S. A.

INTERNATIONAL TEXTBOOK PRESS
Scranton, Pa.

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NOTE.—This book is made up of separate parts, or sections, as indicated by their titles, and the page numbers of each usually begin with 1. In this list of contents the titles of the parts are given in the order in which they appear in the book, and under each title is a full synopsis of the subjects treated.

ADVANCED MECHANICAL DRAWING

Serial 1947B-3 (PART 2) Edition 1

DRAWING PLATES

PLATES 1016 AND 1017, TITLE: BENCH-VISE DETAILS

MAIN FEATURES AND OPERATION OF VISE

1. Preliminary Explanations.—In practice, it is customary to draw a preliminary assembly drawing first, as it serves not alone to show the relative positions of the various parts, but also the available space between adjacent parts, and a possible interference between moving parts. From the assembly drawing, which generally shows only the over-all dimensions, the detail drawings are made. In working out the details, changes will very likely be found necessary, necessitating a corrected assembly drawing. In case of simple objects, the assembly drawing may be provided with dimensions and other necessary information, and may then serve also as a detail drawing.

For instruction purposes it is preferable to draw the detail drawings first, as the assembly drawing will then be more readily understood, and will also be made with fewer errors after the shape and position of the details have been explained.

A general idea of the external appearance of the vise may be had from the perspective view, Fig. 1, and from the three views in the bench-vise assembly, Plate 1018, that represent a rear, a side, and a front view of the vise, respectively. On this plate the numbers in the circles are those given to the various parts in the material list found in the lower right-hand corner.

2. Operation of Vise.—The internal construction of the vise is indicated in the longitudinal section, Fig. 2, which in

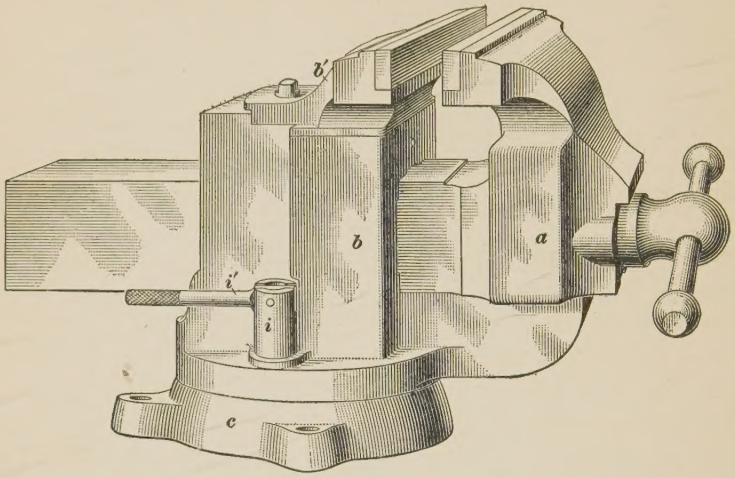


FIG. 1

the following description should be consulted in connection with Fig. 1. The front jaw *a* passes through a rectangular

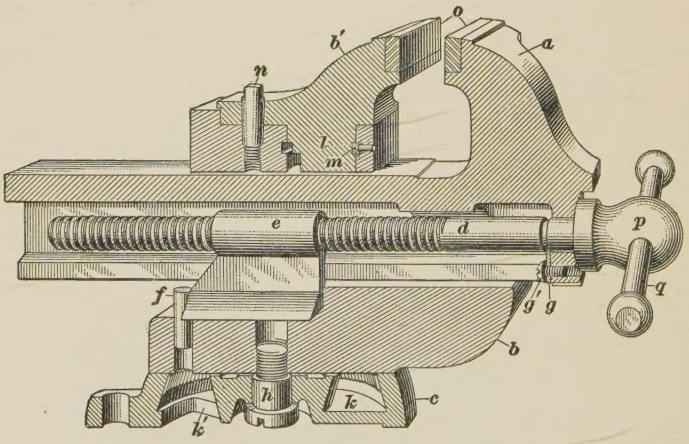


FIG. 2

hole in the back-jaw stock *b*, which rests on the swivel base *c*. As seen from Fig. 2, the jaw *a* may be moved in or out by

means of the screw *d*, which engages the nut *e*. The nut is inserted in a swallow-tailed groove, where it is held in place by the pin *f*. When the screw *d* is turned so as to move away from the nut *e*, the screw fastener *g* compels the jaw *a* to follow, the fastener being attached to the jaw by the screw *g'* in such a position that it will engage a groove in the screw.

The back-jaw stock *b* is attached to the base *c* by the stud *h* in a way that will allow the jaw stock to revolve with the stud. The jaw stock *b* is clamped to the base by means of the clamp-bolt head cast on the lower end of the clamp bolt *j*, Fig. 3, which shows the base of the back-jaw stock *b*, and the swivel base *c*, one end of both parts being shown in section. The bolt *j* engages the clamp nut *i*, which may be turned by the handle *i'*. By turning the handle counter-clockwise, the bolt head will descend out of contact with the walls of the circular groove *k* formed in base *c* The jaw stock is now free to move into any convenient position, thus allowing the mechanic to turn any side of the work, held in the vise, to the front without having to rearrange it in the jaws. The jaw stock *b* is locked into position by turning the handle *i'* clockwise. The grip of the bolt head is increased by providing it on one side with serrations, which engage corresponding ones in the circular slot. In assembling this locking device, the bolt *j* must be inserted from below through the hole *k'* in the base *c*, Fig. 2. Previously, the vise must have been turned into a position in which the bolt hole and the nut, Fig. 3, will aline with the bolt and permit its engagement with the nut.

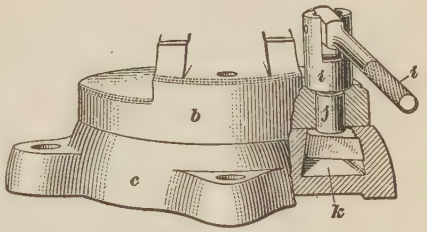


FIG. 3

3. In order that tapered work may be held securely between the jaws proper, the rear jaw stock *b*, Fig. 2, is provided with a swivel jaw *b'*. From the perspective view, Fig. 4, which shows the swivel jaw detached from the back

jaw, it is seen that a post l projects downwards from the base of the jaw. This post rests in a corresponding circular recess in the jaw stock b to which it is locked by a spline m, Fig. 2, projecting into the groove m', Fig. 4, and held stationary in a corresponding groove in the recess.

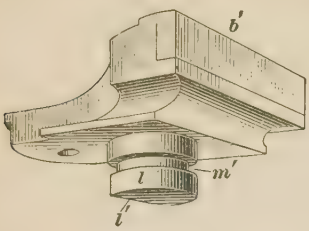


FIG. 4

When the jaw steel on the swivel jaw b' is to remain parallel to that in jaw a, the jaw b' is locked into place by means of the taper lock-pin n, Fig. 2, which passes through a tapered hole in the swivel jaw and screws into a tapped hole in the back jaw itself. When the lock-pin n is removed, the swivel jaw is free to revolve and adjust itself into contact with a tapering side of the work in hand. The jaw steels o are electrically welded to the jaws, therefore they are made a little longer than the jaws and then trimmed to size.

By reason of the spline m fitting the groove m', Fig. 4, the swivel jaw b' cannot be removed or replaced, except in one position. The reason for this may be seen from Fig. 5, which is a botton view of the detached swivel jaw. A segmental portion l' is cut away from the lower end of the post l, as shown also in Fig. 4. By giving the jaw b' half a turn, the cut l' will be opposite the spline m, Fig. 5, and the post will be free to pass over the spline. The spline is prevented from revolving with the swivel jaw by a pin projecting through a hole in the back jaw into a centrally located slot in the spline, as shown in Fig. 5. In the longitudinal section, Fig. 6,

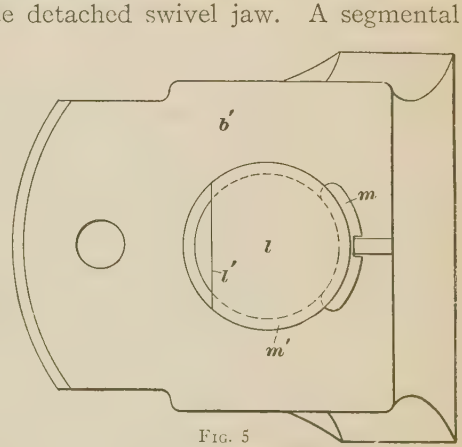


FIG. 5

of the back jaw, the details of the bore intended to receive the post of the swivel jaw are shown with the required dimensions.

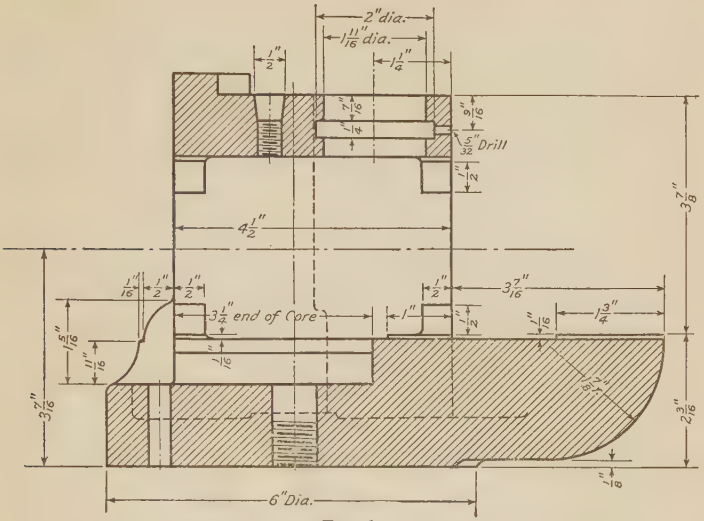


Fig. 6

4. Construction of Screw.—Attention is called to the thread on the screw *d*, Fig. 2, by which the front jaw *a* is moved. This form of thread is known as *buttress thread* and is employed in places where a heavy pressure is to be exerted only in one direction. The side of the thread that faces in that direction is at right angles to the axis of the screw, as are the sides *a* in Fig. 7, which is a portion of a screw shown in a longitudinal section. The active side *a* of a thread of this form is able to exert a pressure at right angles to the corresponding side of the thread in the nut without the accompanying wedge action of the ordinary **V** thread. The rear side *b* of the thread makes an angle of 45° with the side *a*. If the

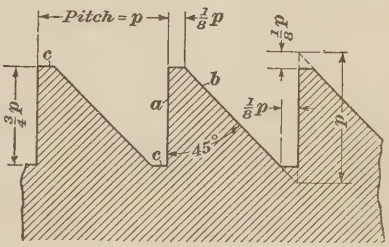


Fig. 7

6. It is seen from the side and the bottom view of part **2,** and more clearly from Fig. 2, that the horizontal extension of this jaw is cored out along its whole length, and that the cavity is of a rectangular cross-section, except for a short distance near the jaw itself, where the upper wall is semicircular. The lower side of the cavity is slotted throughout to allow the entrance of the nut *e*, Fig. 2.

The $1\frac{13}{16}$-inch bore shown in the front-end view is only $\frac{1}{16}$ inch deep, as shown in the side view; it is intended to receive the inner end of the screw head *p*, Fig. 2.

Attention is called to the $\frac{3}{8}'' \times \frac{7}{8}''$ recess made in the top of the jaw to receive the jaw steel. The top face of this steel and the adjoining portion of the jaw proper, are curved to a radius of $2\frac{9}{16}$ inches. In the two end views, the upper edge of the omitted jaw steel is indicated by a dash-and-dot line, as the jaw is to be cast without the recess, the latter being subsequently machined in the jaw casting. The zigzag line attached to the $2\frac{3}{4}$-inch radius at the right-hand end of the side view, indicates that only a portion of the radius is shown, there being lack of space to show the remainder.

7. Back-Jaw Stock.—Near the lower left-hand corner of the plate the back-jaw stock, part **1,** is shown in a plan, a side view, and a front view. Draw the vertical center line, common to the plan and the side view, 2 inches from the left-hand border line, and the vertical center line of the front view $6\frac{15}{16}$ inches from the same border line. Draw the base line of the two lower views $\frac{1}{2}$ inch above the bottom border line, and the horizontal center line of the plan, $5\frac{3}{4}$ inches above the same border line.

The plan and the side view are drawn jointly, the dimensions missing in one being supplied by the other view and corresponding faces being projected from one view to the other.

Attention is called to the low bosses provided at various places in the opening through the back jaw, as well as on projecting portions. It is found that instead of fitting the whole of the sides of the opening to the horizontal extension of the front jaw, it is easier and cheaper to support and guide

the extension only at a few places by means of narrow rectangular bosses. With the exception of these bosses the remainder of the sides of the opening is left in the rough. As shown in the plan and the side view, there are two bosses at the right-hand end of the jaw stock, each $1\frac{3}{4}$ inches long, $\frac{1}{2}$ inch wide, and $\frac{1}{16}$ inch high. Similar bosses are found in the opening in the right-hand wall of the jaw, as shown more clearly in the side view, in the end view, and in the longitudinal section, Fig. 6. These bosses, which are located in the corners of the opening, extend for a distance of $\frac{1}{2}$ inch from each corner. They are $\frac{1}{2}$ inch long, except the two bottom ones, which are 1 inch long. Similar bosses are found in the opening through the rear wall.

In the base of this jaw stock there is at its center a hole threaded for a length of $\frac{3}{4}$ inch for the stud bolt, part **10.** The vertical hole for the post of the swivel jaw, and the recess into which the jaw is to fit, must be studied in conjunction with the swivel jaw *b'*, Figs. 1 and 2.

8. Swivel Jaw.—The swivel jaw, part **3,** is shown in three views; a side view, a bottom view, and a front view. Lay off the vertical center line, common to the first two views, 7 inches from the right-hand border line, and the vertical center line of the front view $4\frac{1}{2}$ inches from the same border line.

Draw the horizontal center line of the bottom view $1\frac{5}{16}$ inches above the bottom border line, and the lower end of the two other views $2\frac{3}{4}$ inches above the same border line. The construction of the swivel jaw and the method used in attaching it to the back jaw have been described. These views should be studied in connection with Figs. 4, 5, and 6.

9. Swivel Base.—The swivel base, part **4,** is shown in a plan, in a side view consisting of one-half of a cross-section and one-half of a full view, and a cross-section taken on the line *A*-*A* in the plan. Lay off the vertical center line, common to the plan and the side view, $2\frac{1}{2}$ inches from the right-hand border line, and the horizontal center line of the plan $2\frac{5}{8}$ inches below the upper border line. The center line of the section

A-A should be $5\frac{1}{16}$ inches from the right-hand border line; its base line, as well as that of the side view, should be drawn $5\frac{5}{8}$ inches below the top border line.

The hole *k'*, Fig. 2, is shown in the upper half of the plan, the section *A-A* being taken through this hole to show its shape. It is advisable first to draw the plan and from this view to draw vertical projectors tangent to the circles to obtain the positions of the corresponding edges and corners in the side view. Care should be used in drawing the sides of the circular groove with an inclination of 70° to the base line. Below the section is shown, in plan, the shape and pitch of the 90 serrations to be formed on the conical face of the core print.

10. Nut.—The stationary nut, part **5,** by which the vise screw is enabled to move the front jaw in and out, is shown in a side view and an end view. Lay off the horizontal center line, common to both views, $5\frac{7}{8}$ inches from the lower border line, and the vertical center line of the end view, $8\frac{1}{8}$ inches from the right-hand border line. Between this center line and the right-hand end of the side view, leave a space of $1\frac{1}{4}$ inches.

It is necessary to draw the end view first, to obtain the positions of the corners at which the swallow-tailed base and the nut proper join the $\frac{3}{8}$-inch stem of the nut.

The diameter of the bore in the nut is slightly larger than the diameter of the screw to give sufficient freedom of motion. In part **5** the diameter is given as a tolerance dimension, indicating that the diameter must not be larger than .888 inch, nor smaller than .880 inch. On the plate the diameter is laid off to the nearest sixty-fourth, or $\frac{57}{64}$ inch.

11. Clamp Bolt Head.—Part **11,** the head for the clamp bolt, is shown in three views; a plan, a rear view, and a cross-section. Draw the vertical center line of the first two views $2\frac{1}{8}$ inches from the right-hand border line, and the horizontal center line of the bolt hole, in the plan, $5\frac{5}{16}$ inches above the lower border line. Draw the base lines of the two lower views $3\frac{7}{16}$ inches from the lower border line, and the center line of

the hole in the cross-section $\frac{7}{8}$ inch from the right-hand border line. This cross-section is taken on the vertical center line of the plan. The circular groove in the swivel base being of a trapezoidal section, the cross-section of the clamp-bolt head must conform to this shape and so must the two end faces shown in the rear view. As stated in the annexed note, the pattern for the head must represent a segment of the core print. The serrations in the groove stopping $\frac{1}{16}$ inch below the upper face of the swivel base, it follows that the clamp-bolt head must be shaped accordingly, as stated in the note above the cross-section.

12. An accurate method of constructing the three views of the head for the clamp bolt, part **11**, is shown in Fig. 8, in which view (*a*) is a copy of the section *A*-*A* of the swivel base, already drawn. To this section is added the clamp-bolt head, shown in a position to comply with the requirement that its top face shall be $\frac{1}{16}$ inch below the upper face of the swivel base. By means of view (*a*), it is possible to obtain the various radii required for drawing the three views shown in Fig. 8 (*b*), these views corresponding with those to be drawn on the plate.

In order that the radii to be obtained from Fig. 8 (*a*) may be clearly distinguished, a short arc is described with each radius from a center located on the center line *xx*. Thus, the radii *a* and *a'* refer to the upper and lower edge, respectively, of the inner face of the bolt head. The radii *b* and *b'* refer to the upper and lower point of the bottom of serration, and the radii *c* and *c'* to corresponding points on the edge of a serration.

13. The method of applying the radii, obtained from Fig. 8 (*a*), to view (*b*) is as follows: On the center line *yy* lay off from the center *d* a distance of $2\frac{3}{32}$ inches to locate the center *e*. Draw the horizontal center line *zz* through the point *e* and on this line lay off on each side of *e* a distance of $\frac{9}{16}$ inch to obtain the points *f* and *g*. Through these points draw verticals to be intersected at *h* and *i* by an arc described with the radius *a*, equal to the radius *a*, view (*a*). Draw the lines *ch* and *ci* of indefinite length to locate the positions of the end faces of the clamp-bolt head. With *e* as center and the radii obtained

from view (*a*) describe the various arcs required for the plan. Construct the serrations as indicated.

To contruct the two lower views, draw the horizontal k $\frac{5}{8}$ inch above the base line j, previously drawn. The rear view is completed by extending the verticals fh and gi to intersect

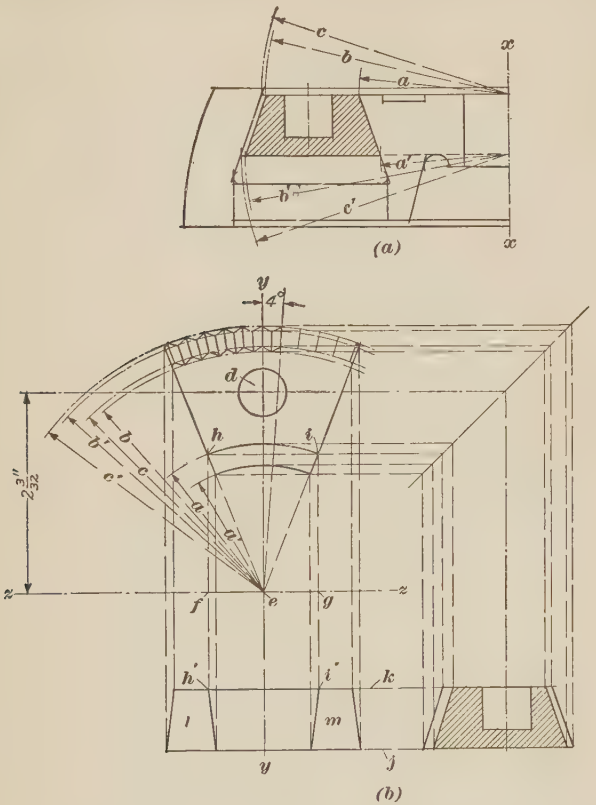


Fig. 8

the line k and obtain the points h' and i'. In a similar manner project other points from the plan to obtain the shape of the two end faces l and m in the rear view.

The points required for constructing the cross-section of the bolt head may be obtained by projection in the manner shown in view (*b*). Or, the required distances may be transferred

Locate the vertical center lines of these views $3\frac{5}{8}$ and $1\frac{3}{8}$ inches, respectively, from the right-hand border line.

16. Draw the horizontal center line of the handle, part **8,** $1\frac{1}{8}$ inches above the lower border line and place the left-hand end of the handle 1 inch from the adjoining border line. The vertical center lines of the side view and end view of the ball, part **9,** placed at each end of the handle, are located $1\frac{1}{2}$ and $3\frac{3}{8}$ inches, respectively, from the left-hand border line; draw their common horizontal center line $3\frac{5}{16}$ inches above the lower border line.

The screw fastener, part **18,** is shown in a front view and a side view. Place the base lines of these views $5\frac{7}{8}$ inches from the bottom border line and draw the vertical center line of the front view $1\frac{1}{4}$ inches from the left-hand border line. Draw the left-hand edge of the side view $2\frac{3}{16}$ inches from the same border line. Draw the center line of the screw, part **19,** 6 inches from the top border line and the base of its head $3\frac{1}{2}$ inches from the left-hand border line.

17. Parts Belonging to Swivel Base.—Draw the vertical center line of the stud, part **10,** for the swivel base $5\frac{5}{8}$ inches from the left-hand border line and place the upper face of the head $5\frac{1}{4}$ inches above the bottom border line. The clamp bolt, part **12,** used in the clamping devise, has its vertical center line drawn 4 inches from the right-hand border line and its lower end $5\frac{7}{8}$ inches from the lower border line. The thread may be drawn as shown; or the beveled top and bottom faces may be omitted, as in the case of the thread in the clamp nut, part **13.**

Draw the vertical center line of the side view and plan of this nut $1\frac{3}{8}$ inches from the adjacent border line, and the horizontal center line of the plan $5\frac{1}{4}$ inches from the top border line. Draw the top of the side view $6\frac{1}{2}$ inches from the same border line.

The horizontal center line common to the side view and end view of the handle, part **14,** for the clamp-bolt nut, is drawn $2\frac{1}{2}$ inches from the lower border line. Draw the vertical center line of the end view and of the rivet hole in the side

21. Lettering.—Finish Plate 1017 by adding dimensions and lettering. The names of the various parts, together with the number required and material used should, where possible, be printed $\frac{1}{4}$ inch below the part, so as to obtain a certain uniformity.

PLATE 1018, TITLE: BENCH VISE ASSEMBLY

INSTRUCTIONS FOR DRAWING PLATE

22. Rear View, Side View, and Front View.—The separate details of the vise having been drawn on Plates 1016 and 1017, it is possible to combine these details into the assembly views shown on Plate 1018, now to be drawn. On this plate a rear-end view of the vise is shown in (*a*), a side view in (*b*), and a front view in (*c*). In the space left below the side view is to be drawn a longitudinal section of the vise, this view resembling in its principal features the view given in Fig. 2. The views on this plate are to be drawn to a scale of 6 inches = 1 foot.

Begin the assembly views by drawing their horizontal center line 4 inches from the upper border line. Draw the vertical center lines of views (*a*) and (*b*) $2\frac{11}{16}$ and $8\frac{1}{8}$ inches, respectively, from the left-hand border line, and that of view (*c*) $2\frac{5}{8}$ inches from the right-hand border line.

The lower portion of view (*a*) is shown, in part, as a half-section, the section being taken on the center line of view (*b*). In drawing the end face of the back-jaw stock in view (*a*), care must be taken to show the short, shallow bosses that support and guide the horizontal extension of the front jaw. The details of the clamping device must be taken from Plates 1016 and 1017. For the sake of uniformity, the handles in views (*a*) and (*c*) should be shown as inclining 35° to a horizontal. The upper end of the handle should be $3\frac{3}{4}$ inches, to scale, from the center of the screw.

Note that in view (*c*) the handle makes contact with only two edges of the hole in the screw head, the diameter of the hole being $\frac{1}{16}$ inch larger than that of the handle. To avoid confusion of lines the diameter of the handle is in these views decreased to $\frac{1}{2}$ inch.

23. In view (*b*), the projection of the end face of the upper ball of the handle appears as an ellipse. The minor diameter of this ellipse may be projected over from the end face of the adjoining ball in view (*c*); the major diameter is equal to the width of the same face. The line of intersection of the handle with the lower ball is also an ellipse, of which the minor and major diameter are obtained from the corresponding line of intersection in view (*c*). The position and shape of the hole in the screw head are obtained in the same manner. Great care should be taken to draw correctly the curved edges of the jaws, as modern practice allows the patternmaker less freedom in forming such edges than was granted him in former days.

The function and location of the various parts must be indicated by their part numbers, enclosed in the usual manner in circles, these numbers to correspond with those given in the material list.

24. Longitudinal Section.—The longitudinal section of the vise, to be drawn as view (*d*) on Plate 1018, is not shown on the sample plate, as the information already provided is considered sufficient for completing this view. Draw the horizontal center line of the screw $2\frac{7}{8}$ inches above the lower border line and extend the vertical center line of view (*b*) to serve the same purpose in view (*d*). The drawing of view (*d*) may be greatly facilitated by projecting some of the center lines and the vertical faces of the parts in view (*b*) down to view (*d*).

Begin view (*d*) by drawing part **1,** setting off its base line $3\frac{7}{16}$ inches below the screw center line, according to the dimension given in view (*b*). The cross-section of part **1,** as given in Fig. 6, will greatly aid in laying off the various faces, holes, and openings. Next, the base line of the swivel base is drawn $4\frac{7}{8}$ inches below the screw center line. The left-hand half of this base is drawn to correspond with the section *A*-*A*, Plate 1016, except that a bolt lug is shown at the left, corresponding with that shown in the main section of the swivel base, located at the right of the section *A*-*A*. For additional information consult Fig. 2. Show the stud, part **10,** for the

swivel base and make the length of the threaded portion according to the dimension given on Plate 1017.

25. Project the screw head, part **7,** down from view (*b*) and show the head in full. Then, draw the screw, showing it throughout its whole length in full and drawing the threads as in Fig. 9. Draw the nut, part **5,** in full, except the portion surrounding the screw, which is shown in a partial, vertical section, the lower end of the section being separated by a broken line from the portion shown in full. Now draw part **2,** showing the jaws closed, as in view (*b*), and the screw handle in a corresponding position. The jaw steels are to be section-lined according to the conventional section used for steel.

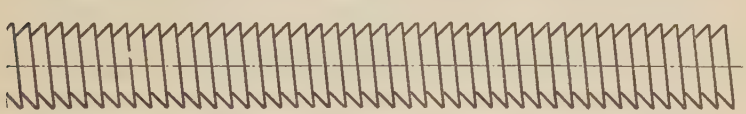


FIG. 9

The lug on the front jaw that supports the right-hand end of the screw is shown in section; likewise the screw fastener, part **18.** Show the shallow recess on the outside of the lug in which the inner face of the head revolves. Note that the ribs at the lower end of the inner walls of the extension of part **2** do not connect with the lug just mentioned, but that there is a space $\frac{5}{16}$ inch wide between the lug and the rib, as shown in the bottom view of part **2,** Plate 1016.

26. While drawing the outline of the swivel jaw, consult the side view of part **3,** Plate 1016. The shape of the cylindrical recess for the swivel-jaw post is obtained from Fig. 6. Show the spline, part **20,** in section, corresponding with Fig. 2, which, on the whole, will be of great assistance in helping to visualize the sectional portions of the longitudinal section. Great care must be taken to show correctly the shallow bosses that support part **2.**

27. After completing the assembly views, indicate the positions of the detail parts by numbers enclosed in circles, these numbers to correspond with those given in the material

ports to connect with the exhaust port *l*. Each time the piston *f* is nearly completing a stroke, the auxiliary piston valve *i*, which is attached to the valve *j*, is moved by steam so as to move the valve *j* in the proper direction. The steam producing this motion is automatically applied by a device operated by the link motion shown attached to the rod *g*.

The valve chamber *m* of the pump contains the suction valves *n* and the delivery valves *o*. The air chamber *p* provides an air cushion for the water alternately forced up through the valves *o*. The piston *e* consists of a piston head *q* and a follower plate *r*, which serve to retain the fibrous packing, which fits the bore of the cylinder.

When the piston *e* moves in the direction of the arrow, the right-hand suction valve *n* opens to permit water to enter from the suction pipe. Simultaneously the left-hand delivery valve *o* opens to allow the water to be discharged into the discharge chamber. On the return stroke of the piston, this pair of valves closes and the other pair opens to repeat the previous actions. The pump cylinder *a* has a removable bronze lining *s*, which can be replaced when worn.

29. Main Features of Pump Casting.—On the drawing plate 1019, part 1 is the pump casting proper. In some of its details it differs from that shown in Fig. 10, but the functions of the various parts are the same. The external appearance of the pump and the valve chambers may be seen from the perspective view, Fig. 11, in which *a* is the cylinder and *b* the front end wall, cast integral with the cylinder. To this end is bolted the stuffingbox *b'* with its gland, through which the piston rod *c* moves in and out. The rear end of the cylinder is closed by the cover *d*, bolted to the end flange *d'*. At *e* is the suction opening with the flange *e'* to which the flange of the suction pipe is to be bolted.

Between the top flange *a'* of the pump casting and the flange *g'* of the cover *g* is inserted the brass valve plate *f*. These three parts are clamped together by ten eyebolts *h*, which are attached by pins to lugs projecting from the pump casting. By loosening the nuts *h'* the bolts may be swung

out of the slots and the cover and the valve plate removed to permit examination or replacement of the valves or some of their parts. At i is a boss to which the lower end of the air chamber is bolted. Into the holes i' may be screwed an air cock or a pressure gauge, if required.

30. The perspective view, Fig. 12, shows the valve casting with the valve plate and the cover removed. A portion of the casting is shown broken away to disclose some of the internal

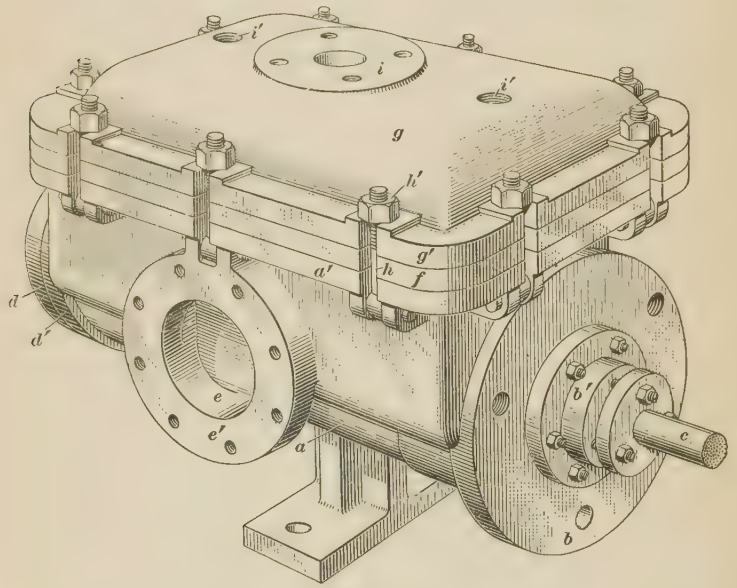


FIG. 11

parts. In this view the casting, Fig. 11, is turned end for end, so that the end cover d is in front and the discharge opening j with the flange j' faces the observer. The internal face of the cylinder is covered with the bronze lining k on which reciprocates the piston l, attached to the piston rod c.

The horizontal partition m, which separates the suction valve chambers n and n' from the suction port o, does not extend to the two ends of the casting, but leaves a port p at each end. Through these ports the suction, or reduced pres-

sure, produced by the piston while moving away from the end d, may be directly transmitted to the suction valves q and cause them to rise and admit water from the port o into either one of the chambers n and n'. The wall m_1 prevents direct communication between these chambers. The inner wall of each suction port p is connected to the adjacent end of the casting by the short bar m_2 to facilitate the coring of the mold. In Fig. 12 the valve is omitted from the chamber n', but a portion of the circular hole into which it is forced, is shown.

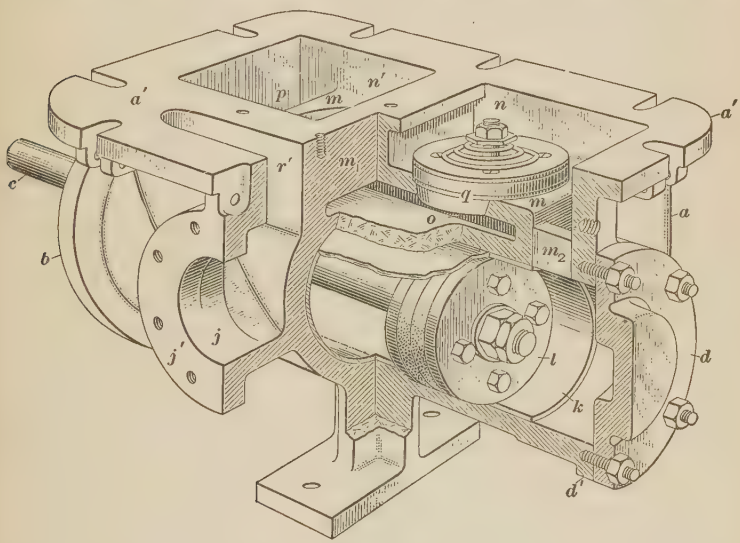


FIG. 12

The ports p communicate also with the lower side of the delivery valves, so that the piston, when moving toward the end d, may force the water from the cylinder up through the delivery valve.

INSTRUCTIONS FOR DRAWING PUMP CASTING

31. End Views.—To distinguish between the two ends of the pump casting, the end in which the stuffingbox is located will be known as the *front end.* In the perspective views, Figs. 11 and 12, this end is indicated by the letter b. This and other reference letters used in these views are also used

on Plate 1019 to assist in locating the various parts. The views on this plate are drawn to a scale of 3 inches = 1 foot.

Begin the plate by drawing the vertical center line *tt* and *uu* $2\frac{11}{16}$ inches and $4\frac{1}{4}$ inches from the left-hand and the right-hand border line, respectively. Across the line *tt* draw the horizontal center lines *vv* and *ww* $2\frac{13}{16}$ and 8 inches from the top border line, respectively. These center lines are used for the front-end view and the rear-end view. Draw first the front flange *b* of $15\frac{5}{8}$ inches diameter, then the circles of $8\frac{3}{8}$ and $5\frac{1}{2}$ inches diameter, defining the outlines of the stuffingbox bushing, as given in the side view of the casting. The bores of the bushing are 3 and $1\frac{3}{4}$ inches, as seen from the longitudinal section, Fig. 2. Add the bolt circles and space off the bolt centers in the manner shown.

32. Represent the flange *d'* in the rear-end view by a circle of $11\frac{1}{2}$ inches diameter; add the bolt circle, the bolt holes and the circles that define the interior of the cylinder. The remaining portions of these views are quite similar, hence, draw in each view a horizontal to represent the upper face of the top flange, which is 10 inches above the center lines *vv* and *ww*. Make the flanges $1\frac{1}{4}$ inches thick and $17\frac{1}{2}$ inches wide according to the adjacent plan view. Below this flange draw in both views the vertical flanges *e'* and *j'* for the suction and the discharge openings, respectively. Note that the distance between the outer faces of these flanges is 17 inches and that the lower portion of each flange is only $1\frac{1}{8}$ inches thick, whereas the upper portion is $1\frac{1}{2}$ inches thick. Draw the center lines of the pin holes for the eyebolts; also the vertical center lines of the recesses in the flanges for these bolts, according to the dimensions in the plan. The latter view shows that the recesses in the flange are rounded off at their inner ends while the spaces between the lugs have sharp corners.

The complete base may now be added to the rear-end view, that of the other end view being broken off below the flange *b*. It remains to indicate in both views by dotted circles the outside of the pump cylinder and by larger semicircles the bosses at each end of the cylinder, shown at *d''* in the side view.

33. Plan View.—Draw the horizontal center line *yy* of the plan $2\frac{13}{16}$ inches below the upper border line. Set off on *yy* on each side of the center line *uu* a length of $13\frac{1}{2}$ inches to locate the ends of the top flange. Above and below the line *yy* set off $8\frac{3}{4}$ inches to obtain the width of the flange. Locate the center lines of the eyebolt recesses, as well as the center lines of the bolt pins. Draw the recesses and the lugs with the pin holes, and round off the corners of the flange with arcs of 3-inch radius.

Next, the centrally located flange m_3 may be drawn $2\frac{1}{2}$ inches wide, and on each side the rectangular openings, $9\frac{1}{2}$ inches long and $8\frac{1}{2}$ inches wide, these openings corresponding with the suction valve chambers *n* and *n'*, Fig. 12. At m_2 are shown the bars that connect the end walls of the suction port with the ends of the casting. The circular, tapering openings made to receive the valve seats have a minimum diameter of 7 inches, as shown in Fig. 1. The positions of their center lines are located in the plan by the dimensions given. Draw the center line of the discharge port *r'* and make the port $15\frac{1}{2}$ inches long and $2\frac{1}{2}$ inches wide. Add the $\frac{5}{8}$-inch tapped holes to receive the four bolts by which the valve brass plate is bolted tight to the central flanges of the pump casting.

The ports *p* at each end of the cylinder are 2 inches wide; they correspond with the ports *p*, Fig. 12, and with the ports *p*, Fig. 2, Plate 1019, and Fig. 1, Plate 1020. The parts of the casting shown in the plan, Plate 1019, that are located below the top flange, such as the cylinder, the cross web m_1, the flanges *e'* and *j'*, the end and side walls of the suction and of the discharge ports, and the lugs for the eyebolts, are all shown in dotted lines.

34. Side View.—The side view of the pump casting, shown below the plan, has its center line *zz* 8 inches below the upper border line. A portion of the flange *e'* of the suction opening *e* is shown broken away to disclose the cross-section of the portion located behind the flange *e'*. The outside wall of the right-hand end of the casting is partly broken away to show the end wall *o'* of the suction port *o*. At the right of this wall

the faces of the flanges e' and j' and from the side view the various vertical faces and walls of the casting. Draw the circles in Fig. 1 to indicate the flange b, and the cylinder with its bushing and openings. Project these parts from Fig. 1 to Fig. 2 after the ports at each end of the cylinder have been laid off. These views should now be completed in this manner, alternately adding corresponding parts to both. The eyebolt, shown in dotted lines in Fig. 1, may be inclined at an angle of 60° to the horizon.

Particular attention is called to a construction feature shown only in Fig. 2; that is, to the dotted semicircles r' representing the shape and thickness of a curved bottom of the discharge port r', also shown in Fig. 12 as leading down to the opening j. The meaning of the lines representing other parts of Figs. 1 and 2 will be understood by consulting other views.

PLATE 1020, TITLE: PUMP DETAILS AND ASSEMBLY

DETAIL DRAWINGS

37. Valve Seats.—The detail drawings on Plate 1020 are drawn half size, except the piston rod, which is drawn quarter size. Draw the vertical center line uu for the views of the valve seats $2\frac{5}{16}$ inches from the left-hand border line and the horizontal center line vv $2\frac{1}{4}$ inches below the top border line. It is seen that the seat contains a number of apertures tapering toward the center of the seat and having end faces constituting portions of concentric circles.

In setting out these apertures, the method shown in Fig. 13 may be used. Draw the circle a with a diameter of $6\frac{3}{8}$ inches to locate the positions of the outermost end faces. The other faces of the apertures are located by the circles b, c, and d of $3\frac{7}{8}$, $3\frac{3}{8}$, and $1\frac{7}{8}$ inches diameter, respectively. Divide any quadrant of the circle a, such as ef into 5 equal parts; then halve one of these parts and set off one half on each side of points e and f, as ee' and ff'. Between the points e' and f' set off four whole parts. Divide the other quadrants in the same manner and draw from each point of division a radial line, as g and h. Halve the part ij at i' and draw a radial line intersecting the circle c at k. The arc kl gives the size of the

ten parts into which the circle c is to be divided, the first part being kl. After radial lines are drawn also from these points of division to the center of the seat, draw at this center a circle m of $\frac{1}{4}$ inch diameter. Then, to locate the side faces of the larger apertures, draw lines, such as n and n', tangent to the circle m and parallel to the radial line through f'. Repeat this operation at all the radial lines drawn from the circles a and c, obtaining the result shown on Plate 1020.

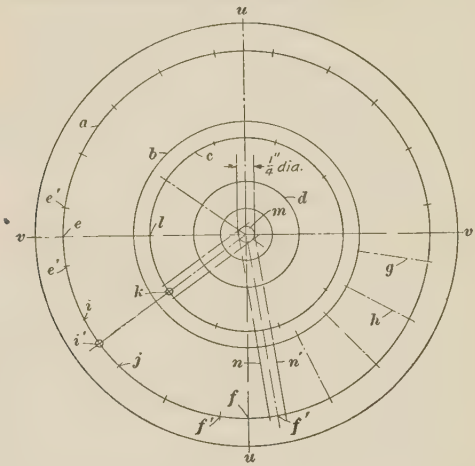


FIG. 13

38. The cross-section of the valve seat, part **8**, is taken on the line vv of the plan. Place the upper face of the valve seat $5\frac{3}{4}$ inches below the upper border line. Project the end faces of the apertures from the plan down to the cross-section. Note that though the line vv passes through two webs of the smaller apertures, these webs are left blank to indicate an opening according to the usual convention. This view is completed by the addition of the brass spindle with its brass nut, shown dotted.

39. Valve Spring, Retaining Nut, and Valve.—In the assembly view, Fig. **1**, the valve seats, disk valves, and springs are shown in position. The disk is of rubber covered with a brass plate on which the lower end of the conical valve spring rests. Above the spring is a retaining nut provided on its

lower face with a boss that fits into the top coil of the spring and thus keeps the spring in a central position.

In drawing these details on Plate 1020, begin with the cross-section of the spring, part **12,** drawing its center line $2\frac{5}{16}$ inches from the left-hand border line and its base line $8\frac{5}{16}$ inches below the top border line. When the spring is expanded, as shown, the method of constructing it is as illustrated in Fig. 14. Construct the cone *abc* with a base *ac* $4\frac{1}{2}$ inches in diameter and the point *b* 2 inches above *ac*. The spring representing a truncated cone, set off the center line of the top coil $1\frac{1}{4}$ inches above *ac*; the diameter of this coil will

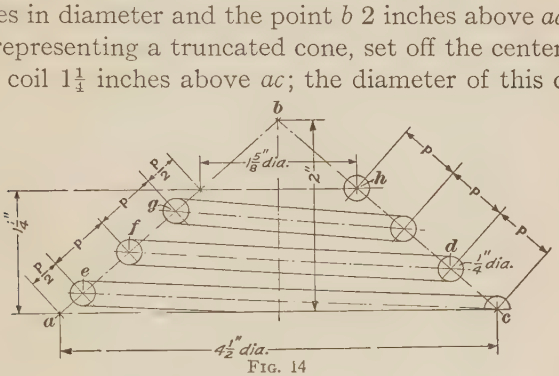


FIG. 14

be $1\frac{5}{8}$ inches. Divide the side *ch* into 3 equal parts, the distance $cd = p$ being the pitch of the coils. Lay off on the side *ab* the distance *ae* equal to one-half the pitch, or $\frac{p}{2}$, and lay off the centers of the wires *f* and *g*, as shown. By drawing the lines *ce*, *df*, etc. the center lines of the coils are obtained. The coils being made of wire $\frac{1}{4}$ inch in diameter, draw circles of this diameter with the points *c*, *d*, etc. as centers. Lines drawn tangent to circles belonging to the same coil, as those at *d* and *f*, give the outlines of the coils.

40. When a spring is to be shown compressed, as in the assembly views, it may be constructed in the manner shown in Fig. 15. On the top face of the valve brass plate lay off the points *a* and *b* at the given distances from the valve center line. Draw verticals through *a* and *b* and from *a* set off the distance *aa'* equal to $\frac{1}{8}$ inch, the radius of the wire. Draw the spring retaining nut with its lower face $\frac{7}{8}$ inch above the valve cover-

plate. Lay off the point c at the given distance above the plate and draw the lines $a'c$ and bc. Locate the center d, as shown, and describe a circle of $\frac{1}{4}$ inch diameter. Divide the distance bd into 3 equal parts and use one of these parts, such as be, to lay off the distances $a'f$ and fg. With the division points as centers, draw circles of $\frac{1}{4}$ inch diameter to represent cross-sections of the wire.

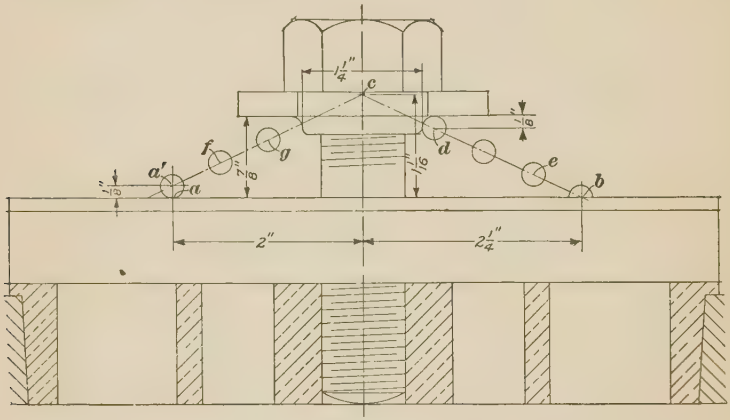


FIG. 15

41. The vertical center line common to the piston rod and the spring retaining nut, part **11,** is drawn $5\frac{1}{2}$ inches from the left-hand border line. The horizontal center line of the nut is 8 inches below the top border line, the nut to be shown in a plan and a side view.

The valve disk, which is shown in a plan and a cross-section, has its horizontal center line $6\frac{1}{2}$ inches below the top border line. The vertical center line of the plan and the bottom face of the section are drawn $3\frac{5}{16}$ inches and $\frac{9}{16}$ inch, respectively, from the right-hand border line. The brass plate is fastened to the hard rubber disk by four flat-headed machine screws.

42. Piston and Piston Rod.—The plan and the cross-section of the piston, shown in Plate 1020, have their horizontal center line drawn $2\frac{1}{4}$ inches below the top border line. The vertical center line of the plan and the bottom face of the piston body, part **9,** are drawn $4\frac{1}{2}$ inches and $\frac{5}{8}$ inch, respectively, from the right-hand border line. Between the follower

plate, part **10,** and the flange of the piston head, two layers of fibrous packing are indicated by dash-and-dot lines. Each layer is a $\frac{3}{4}$-inch square with rounded corners.

Locate the upper end of the piston rod $\frac{1}{2}$ inch and its lower end $6\frac{3}{8}$ inches below the top border line. By reason of its great length, the central portion of the rod is shown broken away to enable the rod to be drawn quarter size. Note that the method of dimensioning the conical ends differs from that

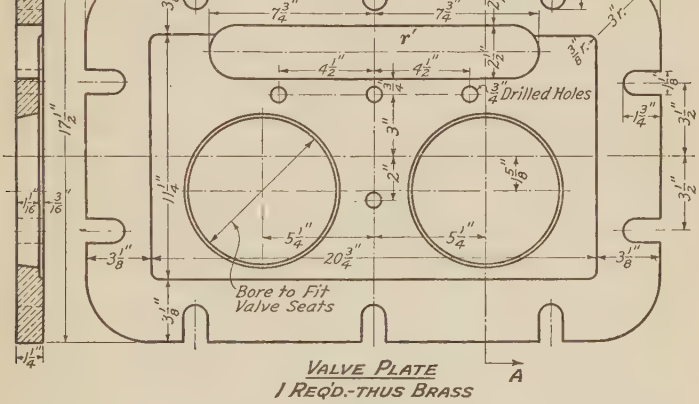


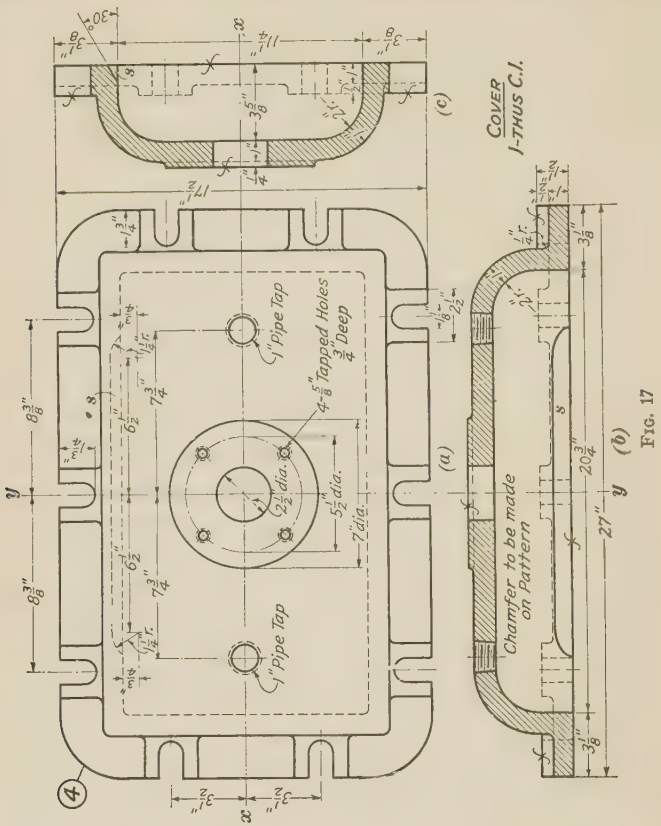
FIG. 16

previously employed, the limiting lines being inclined to the shoulder referred to, instead of being at right angles to it, as usual. The purpose of this variation is to prevent the limiting lines from coinciding with the sides of the conical portion.

43. Other Details.—For lack of space it is necessary to omit from Plate 1020 some of the other details required for completing the assembly views, Figs. 1 and **2.** The details, fully dimensioned, are, however, inserted in the text as Figs. 16, 17, 18, 19, and 20.

44. The first detail to be considered is the valve plate, Fig. 16, shown as part **5** in the assembly, Fig. 1. The detail, Fig. 16, contains a plan of the plate and a cross-section taken on the line *AA*. The plate is provided with recesses for the

eyebolts and a discharge opening r' corresponding with that located in the flange a' of the pump casting. Note that the greater portion of the plate is recessed to a depth of $\frac{3}{16}$ inch;



also, that the openings for the seats of the delivery valves are not central with those for the suction valves. Thus, the distance between the discharge valve centers in Fig. 16 is $10\frac{1}{2}$ inches, while the distance between the suction valve centers is 9 inches, according to the plan view, Plate 1019. The taper of these openings corresponds with that of the valve seat, part **8,** Plate 1020.

45. The discharge valve chamber is formed by the cover, part **4,** shown in Fig. 17, in which view (*a*) is a plan, view (*b*) a

longitudinal section taken on the center line *xx*, and view (*c*) a cross-section taken on the center line *yy* of the plan. In the cover the recesses for the eyebolts are partly surrounded on

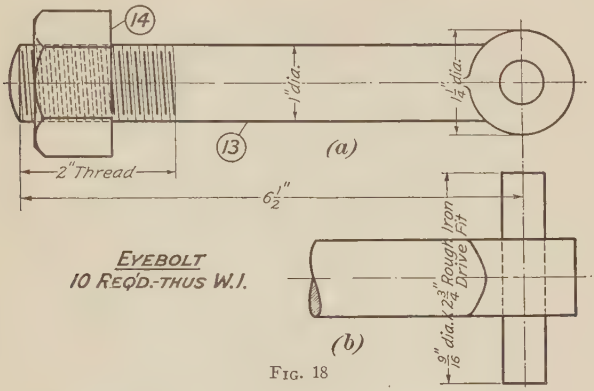


FIG. 18

the top side with a boss to give a finished face for the bolt nuts. A special feature of the cover is the recess *s*, formed near the lower edge of the rear wall to prevent obstruction of the stream of water flowing into the discharge port *r'* in the valve plate.

46. Detail views of an eyebolt are shown in Fig. 18, view (*a*) being a side view and view (*b*) a portion of a front view, which show the length and diameter of the pin.

47. The cylinder head, part **6,** bolted to the rear end of the cylinder, is shown in Fig. 19 in a plan and a cross - section. The fillets and corners are rounded off with arcs of ¼-inch radius.

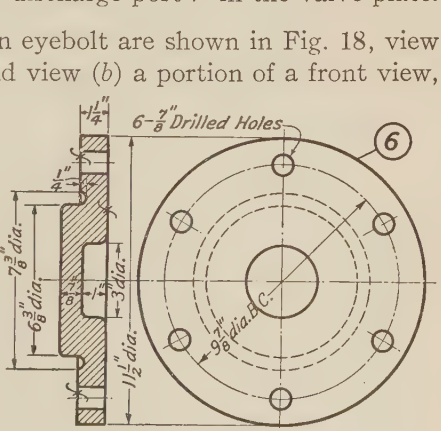


FIG. 19

48. The air chamber, bolted to the top of the cover, part **4,** cannot be shown in the assembly views for lack of space. A detail drawing of this

part is, however, shown in Fig. 20, where (*a*) is a front view and (*b*) a bottom view. In the top of the chamber is a tapped hole to receive an air valve by which an excess of air in the chamber may be reduced. This and the preceding illustrations are fully dimensioned so that no difficulties will be found in adding these parts to the assembly views. The material list for the pump is inserted in the text as Fig. 21.

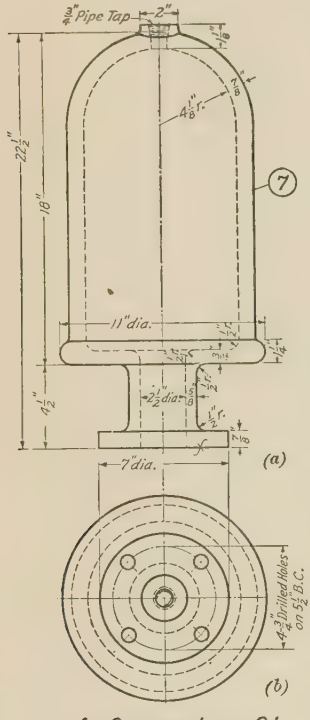


FIG. 20

ASSEMBLY VIEWS

49. Preliminaries.—The lower portion of Plate 1020 is reserved for an assembly drawing of the pump, the drawing to consist of two views, of which Fig. **1** is to be a cross-section of the pump taken on a line corresponding, as to position, with the line *GG*, Fig. 2, Plate 1019. On Plate 1020, Fig. **2** is not shown, it being required to complete this view by means of Fig. **1** in combination with the separate details given on the plates and in the text. Fig. **2** is to be a longitudinal section, taken on the line *BCDEFG*, Fig. **1.** Draw the horizontal center line to serve for both views $3\frac{1}{2}$ inches above the lower border line. The vertical center lines of Figs. **1** and **2** are $2\frac{5}{8}$ inches and $4\frac{1}{4}$ inches, respectively, from the adjacent border lines.

50. Cross-Section.—Begin Fig. **1,** Plate 1020, by drawing the pump casting, corresponding as to general outline with the rear view, Plate 1019. Information as to the parts that will be shown in section is obtained by following the path of the line *GG*, Fig. 2, on Plate 1019. It is seen that the line passes

through the cylinder near the rear end, where one of the ports p is located, and through the bar m_2; then upwards through the valve plate, part **5**, and the discharge valve chamber. The

MATERIAL - LIST
FOR PUMP
SEE DRAWINGS No. 1019 AND 1020.

ITEM No.	DESCRIPTION	MAT'L.	No. REQ.	PATT. No.	DW'G. No.
1	Water End	C.I.	1	1019-1	1019
2	Bushing	C.I.	1	1019-2	1019
3	Gland	C.I.	1	1019-3	1019
4	Cover	C.I.	1	1020-4	
5	Valve Plate	Brass	1	1020-5	
6	Head	C.I.	1	1020-6	
7	Air Chamber	C.I.	1	1020-7	
8	Valve Seat	Brass	1	1020-8	1020
9	Piston	Brass	1	1020-9	1020
10	Piston Flange (Including 4 Tap Bolts)	Brass	1	1020-10	1020
11	Spring Retaining Nut	Brass	4	1020-11	1020
12	Valve Spring	Brass Spring Wire	4		1020
13	1" Eye Bolt	W.I.	10		
14	1" St'd. Hex. Nut	C.R.S.	10		
15	Piston Rod (Complete as shown)	C.R.S.	1		1020
16	$\frac{7}{8}$" x 4" St'd. Stud (For Valve Seats)	Brass	4		1020
17	$\frac{7}{8}$" St'd. Nut (Trimmed to $\frac{3}{4}$" thickness)	Brass	4		1020
18	Hard Rubber Valve - Complete with				
	Brass plate and Screws		4		1020
19	$\frac{3}{4}$" x 3" Studs (with St'd. Hex. Nuts)	C.R.S.	6		1020
20	$\frac{5}{8}$" x 2$\frac{1}{4}$" Studs (with St'd. Hex. Nuts)	C.R.S.	6		1019
21	$\frac{5}{8}$" x 4$\frac{1}{2}$" Studs (with St'd. Hex. Nuts)	C.R.S.	3		1020
22	$\frac{5}{8}$" x 2$\frac{3}{4}$" Studs (with St'd. Hex. Nuts)	C.R.S.	4		
	to fasten Valve Plate to Body				
23	$\frac{5}{8}$" x 2$\frac{3}{8}$" Studs (with St'd. Hex. Nuts)	C.R.S.			
	to fasten Air Chamber to Cover				

FIG. 21

parts situated to the right of the line GG, Fig. **2**, Plate 1019, are shown in full, their outlines and dimensions being obtained from the rear-end view and the plan. Draw the pump casting

according to the dimensions given on Plate 1019. Then add the cylinder bushing and the piston, showing the end of the piston rod with its nuts and washer, shown in the detail drawing of the piston rod.

A valve seat and valve may now be inserted in the suction-valve chamber, it being noted that only the $\frac{1}{8}$-inch flange of the seat appears above the floor of the valve chamber. Next, the valve stud is added, the spring being compressed within a space of $\frac{7}{8}$ inch, so that the coils are brought closer together. The assembly drawing of the valve, valve stud, spring retaining nut, spring, and stud nut is shown in Fig. 15.

The valve plate, part **5,** is placed on top of the pump casting and fastened to it by means of four cap bolts, inserted in the $\frac{5}{8}$-inch holes provided for them; these bolts are, however, to be omitted from Figs. **1** and **2,** Plates 1019 and 1020. Next, show the valve seats, valves, studs, and springs assembled in the discharge chamber, according to Fig. 15. The cover, part **4,** is placed on top of the valve plate, and the eyebolts, previously pinned to their respective flanges, are shown in a vertical position with their nuts tightened. Finally, the lower end of the air chamber, part **7,** is shown bolted to the cover, the bolts, however, being omitted in the assembly. The greater portion of the air chamber must be shown broken away for lack of space.

51. Longitudinal Section.—The longitudinal section, Fig. **2,** taken on the line *BCDEFG*, Fig. **1,** may now be drawn in the same manner. First draw the pump casting, copying for the purpose the longitudinal section, Fig. **2,** Plate 1019, but omitting the cap-bolt bosses shown projecting below the top flange, because they will interfere with the outlines of the valve mechanism. Add the stuffingbox bushing, part **2,** but omit the bolts that fasten it to the cylinder. Insert the gland, part **3,** and show in the upper hole a stud with which to hold the gland in place. Leave a space of 1 inch between the flange of the gland and the end of the bushing, part **3.** Show the piston in the middle position of its stroke and add the piston rod with the nuts and washers at the end. Break off

the piston rod at the place where it emerges from the gland. The bolts that fasten the follower plate, part **10,** to the piston head, part **9,** are to be omitted.

Add the valve plate, part **5,** and the cover, part **4.** Note that that the portion *DE* of the line of section *BCDEFG*, Fig. **1,** passes through the center line of the valve seats. It follows that all the valve seats will be in section and appear as in the cross-section, taken through part **8** on this plate. Show three of the valve disks in full, as in Fig. **1,** and one in section, corresponding to the section of part **18,** except that the screws are omitted. Show the springs in section, as in Fig. **1,** and the retaining nuts, part **11,** with the brass nuts. The portion of the brass studs that extends below the valve disks through the holes in the valve seats, must be shown flush with the bottom face of each valve seat and be provided with threads.

The longitudinal section through the cover, part **4,** corresponds with that shown in Fig. 17 (*b*). In copying this section, omit the rear portion of the flange, shown in dotted lines. Show an eyebolt in position at each end of the cover, corresponding with those shown in Fig. **1.** Finally, show the lower end of the air chamber, part **7,** in place, but break off the tubular portion at a place about $2\frac{1}{4}$ inches, to scale, above the air chamber base. The bracket that supports the pump is shown broken off, as on Plate 1019, to leave room for the title, which is inserted in a space 4 inches long and $1\frac{1}{2}$ inches wide. Include the head, part **6** with studs and nuts.

PLATE 1021, TITLE: DETAILS OF BEARING

MAIN CONSTRUCTION FEATURES

52. Means of Alinement.—On Plate 1021 are shown the details of a self-alining bearing, and on Plate 1022 an assembly of the bearing and its housing. This bearing is intended for an electric generator, which generally contains two of these bearings, one for each end of the shaft. The shaft supports the armature and allied parts, which revolve inside the stationary parts of the generator. In order that the shaft may turn freely and not be subjected to any bending action,

the two bearings must always be exactly in line. To insure a correct alinement and prevent a possible overheating of the bearing as a result of any bending of the shaft, the bearings are made self-alining; that is, they are so supported in the pedestals as to be able to adjust themselves to any slight variations in alinement.

The perspective view, Fig. 22, shows the housing cap a bolted to the pedestal b by means of the bolts c. At the line of

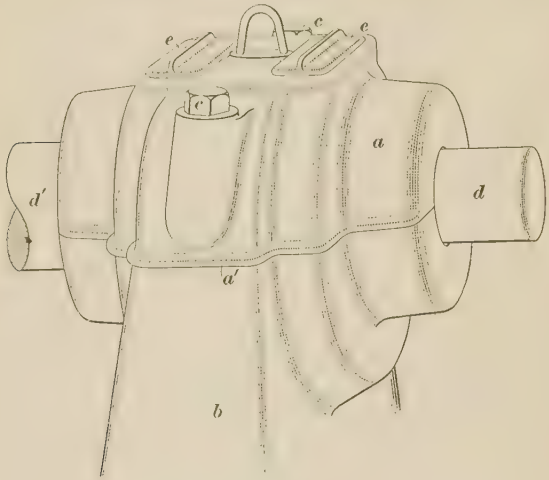


FIG. 22

junction with the pedestal, the cap has a headlike projection a'. The end d of the generator shaft is seen to project at the right through a bore formed jointly by the pedestal and the cap; the end d' of the shaft is shown as if broken off.

The bearing is lubricated in a certain manner, to be described farther on, by oil contained in a reservoir formed in the upper part of the pedestal. The required amount of oil may be poured into the reservoir through an opening, ordinarily closed by a hinged lid.

53. Construction of Bearing.—The perspective view, Fig. 23, is a longitudinal vertical section of the housing cap a and the pedestal b intended to show the construction and relative position of the parts of the bearing. The bearing is

known as a *split bearing*, because it is divided into a top half h and a bottom half i, the lines of division lying in a horizontal plane passing through the center line of the shaft. The front dividing line cannot be seen in Fig. 23, because the front portion of the top half h and the upper portion of the bottom half i are cut away to show the interior construction of the bearing.

The bearing, as a whole, rests with its annular boss i' on a semicircular flange j, supported by the web j_1, which projects upwards from the bottom of the oil reservoirs k and k'. Because of the hole j_2 in this web the oil maintains the same level in both reservoirs. Through an opening l in the rear wall of the pedestal, the level of the oil may be ascertained and oil may be poured to maintain a uniform level. The hole is

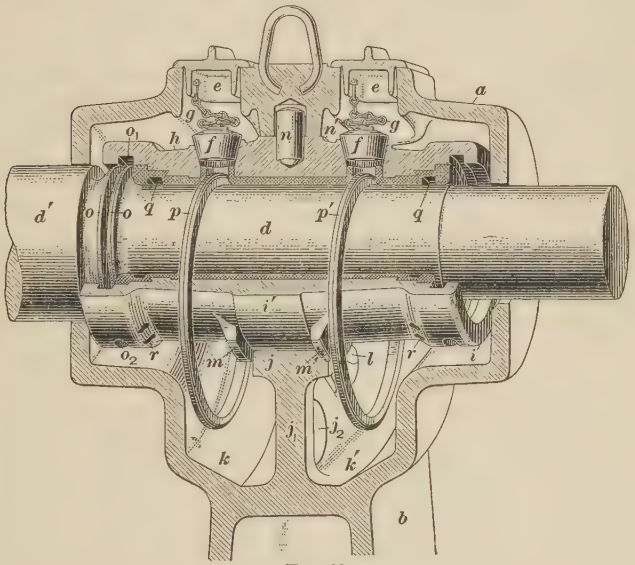


Fig. 23

ordinarily closed with a cover, represented as part **6** in the cross-section, Fig. **1,** Plate 1022. On the same plate this hole is shown in the assembly of the pedestal.

Considering the bearing halves h and i, Fig. 23, as a unit, the boss i', and thus the whole bearing, is prevented from moving longitudinally on the flange j by the ribs m and m',

which are cast on the lower bearing-half *i*. The bearing is, however, allowed a small angular movement around the *steady pin n*, as the center of the motion, thus compensating for any inaccuracy in the shaft alinement. The steady pin serves also to prevent the bearing from revolving with the shaft as a result of a tangential frictional pull of the shaft.

54. Lubricating Device.—The amount of friction produced on the contact surfaces of the revolving shaft and its bearing depends on the kinds of material used, certain combinations producing less friction than others. For instance, it has been found that the friction between a steel shaft and a bearing made of a softer material is less than the friction between two hard materials. So, bearings are generally lined with babbitt or a similar soft alloy, the cast iron shell providing the required strength for maintaining the shape of the bearing.

The principal means, however, for reducing friction to a minimum is to provide a uniform and constant flow of oil between the contact surfaces. To insure the efficient oiling of the bearings, they are mostly made self-oiling; that is, a means is provided by which the oiling is done automatically.

In the bearing, Fig. 23, this is done by suspending from the shaft *d* the loose rings *p* and *p'*, which dip into the oil contained in the reservoirs *k* and *k'*. When the shaft revolves, the rings turn with it by adhesion and carry oil from the reservoirs to the shaft, from where it passes into the helical oil grooves cut into the babbitt lining. These oil grooves are shown clearly in Fig. 24 (*a*), which represents the top half *h* of the bearing in an inverted position. The action of these grooves may be seen more clearly in the longitudinal section of the bearing, Fig. **2,** Plate 1021. This section shows the parts in relative positions corresponding with those in Fig. 23, but without the shaft, thus making it possible to trace the passage of the oil. In the case of the ring *p*, Fig. 23, the oil flows from the top of the shaft into the helical groove p_1, Fig. **2,** Plate 1021, and downwards to the left. Another portion of the oil flows into the groove p_2 toward p_3, where a junction takes place with the groove p_4, the oil supplied by both grooves descending through

the remainder of the grooves toward the left and the right, respectively.

The oil supplied by the rings to the bearing will gradually flow toward the ends and enter the annular grooves q, Fig. 23. The oil collecting in the lower portions of these grooves flows

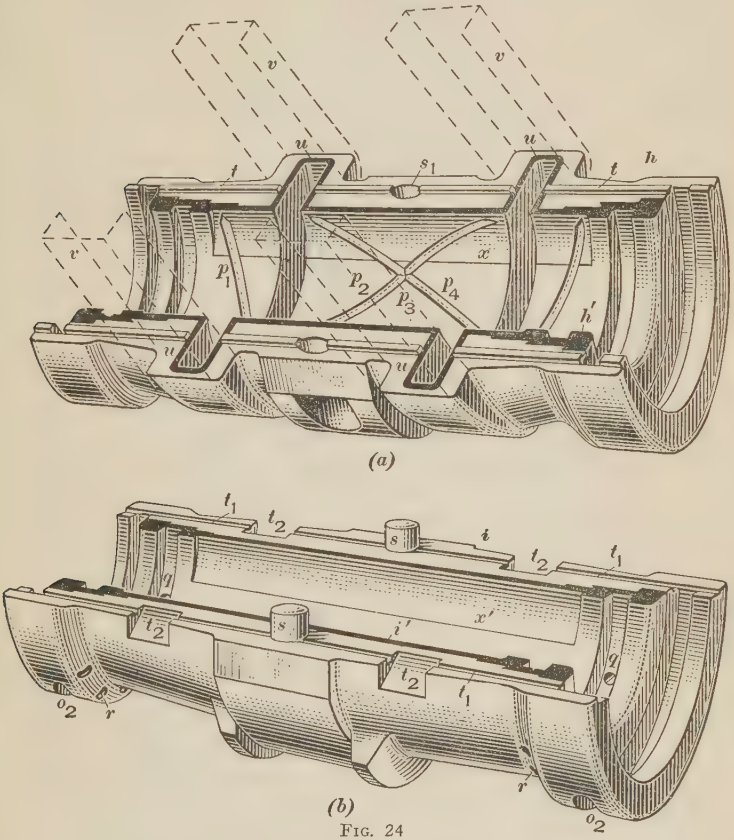


FIG. 24

through the holes r into the oil reservoirs. It is essential that the oil shall not proceed along the shaft beyond either end of the bearing. This is particularly important at the end d' of the shaft, Fig. 23, where the armature is located, as no oil must come in contact with its insulating material. Hence, at this end there are two *oil throwers* consisting of the two ridges o

turned on the shaft. As soon as any oil reaches these ridges, centrifugal forces will throw the oil outwards into the groove o_1, from where it flows through the opening o_2 into the reservoir.

55. Separate views of the bearing halves h and i are also shown in Fig. 24, in which view (a) shows the top half and view (b) the bottom half. Parts corresponding with those shown in Fig. 23 are indicated by similar reference letters. The additional reference letters used for the oil grooves correspond with those found on Plate 1021. Particular attention is called to the means provided for locking the halves together and securing their correct alinement. The lower half i has two dowel pins s, which engage corresponding holes s_1 in the top half h and thus prevent relative longitudinal motions of the halves. Perfect alinement of the parts h and i is secured by the rectangular tongues t in the part h engaging corresponding grooves t_1 in the part i.

56. It is seen from Fig. 23 that the oil rings p and p' are located *inside* the top half h and outside the bottom half i of the bearing. It follows that where they emerge from the top half and begin to embrace the lower one, recesses must be provided for the rings to allow sufficient rooms for motion. Such recesses are shown at t_2 in the lower half, Fig. 24 (b). It also follows that the top cover h must have circular recesses of a diameter sufficiently large to permit the oil rings to swing outwards to one side or the other, as a result of the tangential frictional pull of the revolving shaft. These grooves are shown at u in Fig. 24 (a). One of the grooves is shown in a cross-section at u in the right-hand transverse half-section, Fig. **1**, Plate 1021.

Longitudinal motion of the babbitt lining in the bearing halves is prevented by the rectangular and by the dovetail-shaped shoulders found at each end of the babbitt lining. Conical buttons, or anchors, $\frac{1}{2}$ inch in diameter, project at intervals from the back of the lining into corresponding holes in the cast-iron shells, to serve as additional means for holding the lining in place. To avoid confusion, these anchors are

not indicated on the plates, except at the top of the circular recesses u, shown in the half-section, Fig. **1,** Plate 1021, where the anchors are shown to have a diameter of $\frac{1}{2}$ inch at the base and to be $\frac{1}{4}$ inch high.

As shown more clearly in Fig. 24 (a), the recesses u are lined on all sides with babbitt to reduce the wear of the oil rings while they are thrown outwards against the walls of these

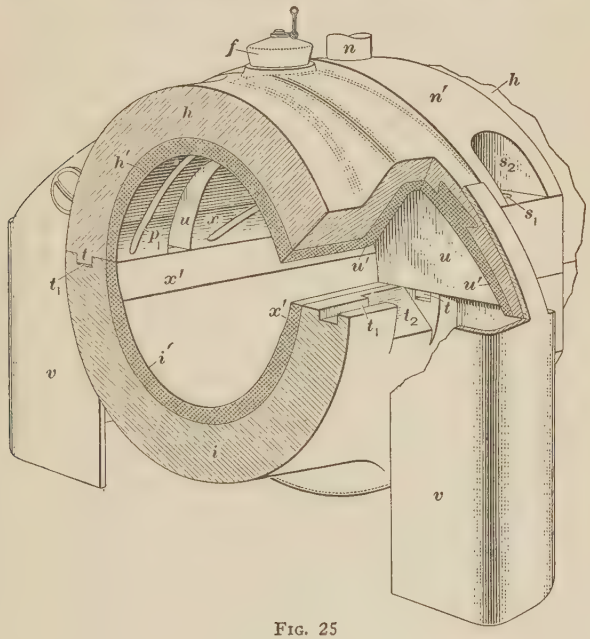


Fig. 25

recesses. The oil splash guards v, shown in dotted lines in Fig. 24 (a), and in section in the cross-section, Fig. **1,** Plate 1021, prevent any oil from splashing from the rings toward the junction at a', Fig. 22, where oil would leak through and flow down the side of the pedestal.

57. A perspective view of the central portion of the bearing is shown in Fig. 25 to illustrate more clearly some of the construction features. Parts corresponding with those shown in Figs. 23 and 24 are indicated by similar letters. On the

Begin Plate 1021 by drawing a horizontal center line across the plate $5\frac{7}{8}$ inches above the lower border line. Across this line draw a vertical center line CD $5\frac{1}{8}$ inches from the left-hand border line. This line is used for Figs. **2** and **3,** the former being a longitudinal section of the bearing and the latter a combination half-plan. The vertical line xx is erected 4 inches from the right-hand border line to serve as center line for Fig. **1,** which is a combination of two half-sections. In drawing Figs. **1** and **2** both views on the sample plate must be consulted to obtain the required dimensions. It is preferable to draw them jointly, as far as possible; that is, to finish the drawing of similar parts in the two views before proceeding to draw other parts. Figs. **1, 2, 3, 4,** and **5** are to be drawn full size and the sections EF and GH, half size.

59. Begin Fig. **1** by drawing a circle 3 inches in diameter to represent the inner face of the babbitt lining. The outer one is represented by a circle $3\frac{3}{8}$ inches in diameter, as shown in the sectional detail, Fig. **4.** The method of drawing the arcs to represent the recesses x and x', Figs. 24 and 25, is shown only for the section CD; but it is understood that the same construction applies to the section AB. The centers for these arcs are located on the inner face at distances of $\frac{5}{8}$ inches above and below the main center line. The section CD is preferably drawn first. As the section is taken on the line CD, Fig. **2,** this view must be consulted for the required information. It is seen that the line of section passes through the central boss and through the hole for the steady pin; also through the dowel pin, part **3,** and the adjoining recess. The diameter of the central boss being $5\frac{1}{2}$ inches, draw a circle with this diameter to represent the main outline of both half-sections. This part may be shown in Fig. **2** by projecting the top and the bottom point of the circle to the line CD. Draw short horizontals through these points and lay off on them the width of the boss, as given in Fig. **2.** Through the points, laid off, draw dotted vertical lines, as shown, to represent the boss. In Fig. **2** the top part of the intersection of the dowel-pin recess with the bearing boss is semicircular.

60. The dowel pin, part **3,** may now be drawn in Fig. **1,** first setting off its center line $2\frac{1}{8}$ inches from the line xx. Note that the rear wall of the recess above the pin leans to the right. These parts are now projected to Fig. **2** and indicated by dotted lines. The steady pin, inserted in the top of the central boss, is shown in dotted lines in Fig. **1.** The corresponding hole is there shown in a half-section and in a complete longitudinal section in Fig. **2.** The right-hand half-section, taken on the line AB, Fig. 2, may now be completed according to the dimensions given, particular attention being paid to the various radii and to the centers from which the arcs are drawn. In this view the radius of the outer face of the bottom half is not given; this radius must be taken on the line AB, Fig. **2.** The arrows on the lines AB and CD all pointing to the left, the respective sections will show the ribs m and m', Fig. 23, on both sides of the boss. Hence, draw two arcs of the same radius, each extending 2 inches on opposite sides of the line xx.

The splash guards may now be shown on both sides of the bearing, that on the left being partly broken away to provide needed room. The positions and shape of the screws with their lock washers, parts **5** and **6,** respectively, should now be drawn. Draw the lock washers with a diameter of $\frac{15}{32}$ inch and the screw heads with a diameter of $\frac{1}{2}$ inch, placing the center of the semicircles midway between the top and bottom face of the washers. Other minor details may then be added, such as the countersunk part of the oil hole and the tongues and grooves at the junction of the bearing halves, detail dimensions of which are found in Fig. 5.

61. Longitudinal Section.—The drawing of the longitudinal section, Fig. **2,** may be begun by drawing a vertical line on each side of the line CD at a distance from it of $4\frac{11}{16}$ inches to represent the end faces of the bearing. Intersect these lines by short horizontals drawn $2\frac{5}{8}$ inches above and below the center line to define the positions of the end bosses. The width of these bosses is defined by verticals drawn $1\frac{1}{4}$ inches inside the end faces. These lines, one of which coin-

cides with the section line *EF*, serve also as center lines of the grooves located at these places. After the $4\frac{1}{16}$-inch bore and the adjoining $\frac{3}{8}$-inch groove are drawn at each end of the bearing, the inner face of the babbitt lining may be indicated by two horizontals projected from the top and the bottom point of the corresponding face in Fig **1.** After the end faces of the lining are rounded off by arcs of $\frac{1}{4}$-inch radius, as specified in Fig. **4,** the outer face of the babbitt lining may be drawn, beginning with the bottom half. The dimensions of the annular projections that anchor the lining to the shell are shown in detail in Fig. **4.**

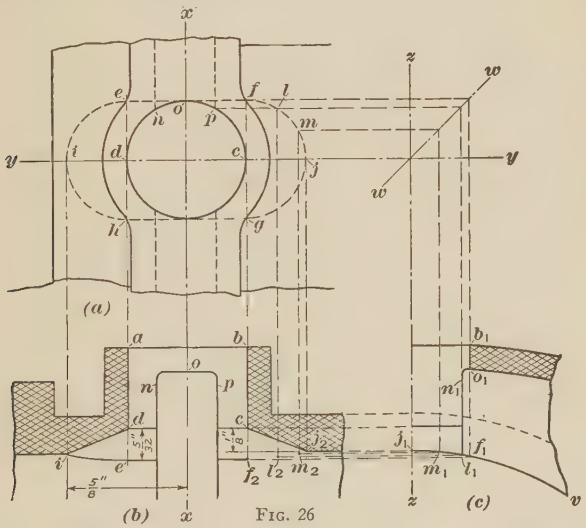


FIG. 26

62. In drawing the cylindrical oil holes in Figs. **2** and **3,** there is one feature that may be difficult to visualize, namely, the true shape of the lower enlarged portion of these holes. For this reason, separate views of an oil hole are shown in Fig. 26, where view (*a*) is a plan in which *xx* and *yy* are the transverse and the longitudinal center lines, respectively. View (*b*) is a longitudinal section through the hole, and view (*c*) a cross-section, taken on the center line *xx*, view (*b*).

In view (*b*), *abcd* is the cylindrical portion of the oil hole to which is joined a rectangular extension $cdef_2$, which in the

plan, view (*a*), appears as the square *cfgh*. To the latter are joined at opposite sides the semicones *chi* and *fgj*. These semicones are shown in view (*b*) at *dei* and cf_2j_2. From the fact that the semicones intersect the cylindrical face of the babbitt lining their lower edges will not be horizontal, but curved, as shown.

The upper end of one of the recesses for the oil ring, located at this place, and corresponding with those shown at *u*, Figs. 24 and 25, is shown at *nop*. The same recess is shown in view (*a*), Fig. 26, to intersect the cylindrical portion of the oil hole at *nop*. The sides of the recess, proceeding from the points *n* and *p*, are indicated by dotted lines at right angles to the line *yy*. A similar recess is shown at the opposite side of the hole.

63. There will now be little difficulty in laying off the oil holes in Fig. 2, Plate 1021. First draw the recesses for the oil rings, also the recesses shown at *x* and *x'*, Figs. 24 and 25. The upper end of the oil hole and of the recess for the ring must be obtained by projecting lines from the corresponding parts in Fig. 1; so must the upper and lower edge of the recesses corresponding to *x* and *x'*. After the lower edge *cd* of the oil hole, Fig. 26, is drawn, draw the horizontal ef_2 $\frac{5}{32}$ inch below *cd*. Then draw the arcs *ei* and f_2j_2 by means of an irregular curve.

64. In case it is desired to obtain the curves *ei* and f_2j_2, Fig. 26, by projection, instead of drawing them approximately correct, in the manner shown at *ei* at the left of the line *xx*, view (*b*), the method shown on the right of the line *xx* may be used. Divide the quadrant *fj*, view (*a*), into any convenient number of equal parts, in this case three, as *fl*, *lm*, and *mj*, and from *f*, *l*, *m*, and *j* draw vertical projectors of indefinite length across view (*b*). Project the points *f*, *l*, and *m* to the line *ww*, inclined at 45°, and from the points of intersection on this line draw vertical projectors to meet the arc j_1v in the points f_1, l_1, and m_1. The arc j_1v is drawn from a center on *zz* with a radius of $1\frac{1}{2}$ inches, corresponding with that of the bore of the babbitt lining. Draw horizontal projectors from the

points, just obtained, to intersect the vertical projectors, previously drawn, in the points f_2, l_2, m_2, and j_2, which are points on the lower edge of the oil hole. Connect these points by a curved line, corresponding with the line ei, already drawn.

65. When the helical oil grooves p_1, p_2, and p_4, milled in the babbitt lining, Fig. **2,** are being drawn, no attempt should be made to show them correctly projected, as this would be

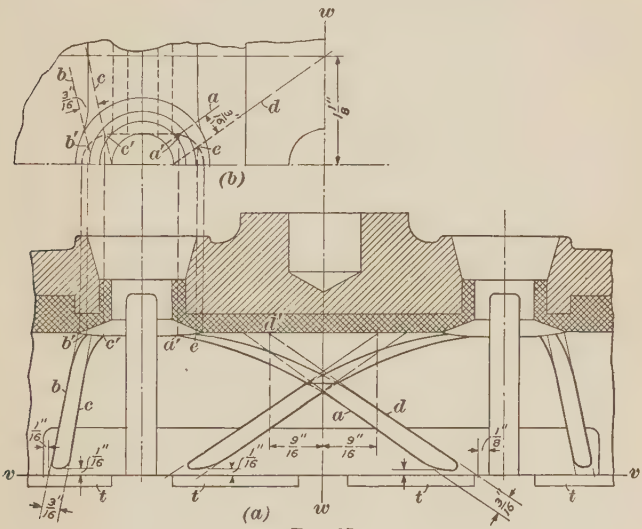


FIG. 27

time wasted, the cutting device used in forming them giving the correct shape of the grooves, irrespective of the drawing. The method by which the grooves may be drawn sufficiently correct for the present purpose is illustrated in Fig. 27, in which view (*a*) applies to the longitudinal section, Fig. **2,** and view (*b*) to the half-plan, Fig. **3.**

Proceed to draw the groove p_1, Fig. **2,** in the manner shown in Fig. 27 (*a*). According to this view the lower end of all the oil grooves stop at a distance of $\frac{1}{16}$ inch above the center line *vv* of the bearing; hence, draw a horizontal at this distance above *vv* to locate the lower end of the grooves. Locate the sides *b* and *c* of the groove p_1 in the manner shown, the position

of the upper ends of these sides being located by points b' and c', projected down from the plan, view (b), where the dotted lines b and c, drawn $\frac{3}{16}$ inch apart, represent a plan of the groove. As shown in view (a), the upper ends of the lines b and c are joined by easy curves to the points b' and c', where the oil groove enters the base of the oil hole. The place of entrance should properly be indicated by a small arc, but is preferably omitted. Draw the groove p_1 at the other end of the bearing in a similar manner.

The lower straight portion of the oil groove p_2 may now be drawn. The straight portion of the side d, Fig. 27, produced, will intersect at d' the bore of the bearing, and at the lower end the center line vv, as shown. Draw the side a parallel to d and connect the lines a and d to the points a' and e', respectively, by arcs, as shown, drawn by means of an irregular curve. The points a' and e, which are projected down from view (b), represent points where the groove ad in the plan intersect the conical base of the oil groove. Draw the groove p_4, Fig. 2, in the same manner and indicate the place of intersection with the groove p_2 by means of a cross, as shown. In Fig. 27 (a), the parts t are the tongues that engage corresponding grooves t', as shown in Figs. 24 and 25.

66. Conical, or tapered, portions of the bearing connect the end bosses with the central boss, as shown in Fig. 2. The method of setting off this taper is shown in the right-hand half of the view, where a diameter of $4\frac{5}{8}$ inches is laid off on the left-hand edge of the last groove. Lines connecting the ends of this diameter with a diameter of $4\frac{7}{8}$ inches, laid off on the right-hand side line of the central boss, will give the required taper for one half of the bearing. The taper of the other half is laid off in the same manner. Note that the limiting lines of these dimensions are not drawn at right angles to, but inclined to, the edges to which they refer. This is done to avoid confusion with the taper lines.

67. Supplementary Cross-Sections.—The cross-sections, shown in the upper right-hand corner of the plate, are taken on the lines EF and GH, Fig. 2. In drawing these views, which

are half-size, locate the vertical center lines of the sections *EF* and *GH* $1\frac{1}{2}$ and $4\frac{1}{2}$ inches, respectively, from the right-hand border line and draw their common horizontal center line $1\frac{1}{2}$ inches below the top border line. The distance from center to center of the inner ends of the holes, shown in section *EF*, is $\frac{5}{8}$ inch.

In the groove in Fig. 2 through which the section *EF* is taken, the circular holes appear as ellipses. To draw the latter approximately correct, and thus avoid needless projection, the horizontal center lines of the ellipses may be drawn in Fig. 2 at distances of $\frac{1}{16}$, $\frac{1}{4}$, and $\frac{5}{8}$ inch, respectively, from the bottom line of the groove. The length of the minor axes of these ellipses may be obtained by projecting the inner ends of the holes to the vertical axis of the section *EF*. It is to be remembered that the lengths obtained are only half-size, while Fig. 2 is full size.

Section *GH* gives the diameter of the groove located at each end of the bearing, also the length of the bottom opening. From Fig. 3 it is seen that the opening has semicircular ends. In the section *GH* project the top and bottom point of one end of the opening to the vertical center line of the section, thus obtaining two points on the latter. Measure the distance between each of these points and the horizontal center line. Lay off twice the length of these distances from the horizontal center line of Fig. 2 along the section line *GH* to obtain the upper points of the curved ends of the bottom openings.

68. Combined Half-Plans.—The combined half-plans, Fig. 3, have their common horizontal center line located $3\frac{7}{8}$ inches below the top border line. An extension of the vertical center line of Fig. 2 serves a similar purpose in Fig. 3. The left half-plan is a plan of the top half and the right half-plan is a plan of the bottom half of the bearing.

The end bosses, the center boss, the recesses, and the chamber for one oil ring, as well as the splash guard, may be projected up from the section, Fig. 2. The position of the groove for the tongue, which is to be shown in the bottom half of the bearing, must be obtained from Fig. 1, also, the

various diameters of the babbitt lining and its recesses. The diameter of the end groove in the bearing, the positions of the center lines of the ellipses representing the inner ends of the circular holes in the adjoining groove, and the lines of junction between the babbitt lining and the shell must be taken from Fig. **2** and section *EF*.

69. Projection of Oil Discharge Holes.—To assist those that desire to make an accurate, instead of a conventional, projection of the oil discharge holes shown in Figs. **2** and **3**, Plate 1021, the supplementary illustrations Figs. 28, 29, and 30 are used. Fig. 28 refers to the oil discharge groove located

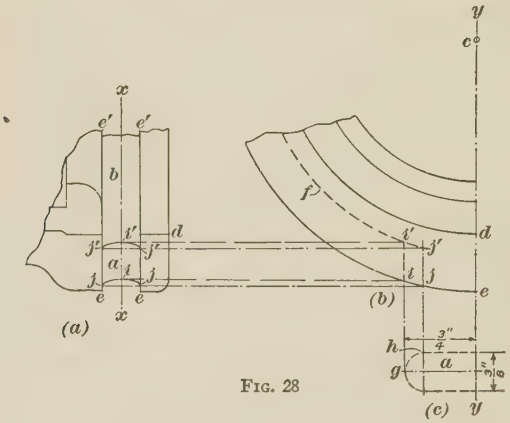


FIG. 28

at each end of the bearing. The oblong opening *a* made in the bottom of the groove *b*, Fig. 28 (*a*), is $1\frac{1}{2}$ inches long according to the section *GH*; its width is $\frac{3}{8}$ inch. Draw in Fig. 28 (*a*) a portion of the longitudinal section, in view (*b*) a partial cross-section, and in view (*c*) a half-plan of the hole *a*. Preferably, the whole of Fig. 28 should be drawn on the plate, but for lack of space it will be necessary to draw views (*b*) and (*c*) separately and transfer the results obtained to Fig. **2**. In Fig. 28 draw the center lines *xx* and *yy*, and with *c* as a center draw, in view (*b*), arcs through the points *d* and *e* to represent the top and bottom edge of the right-hand end of the bearing. The dotted arc *f* indicates the bottom of the groove *b*, view (*a*).

Below view (*b*) draw view (*c*) to represent a half-plan of the opening *a* and from the points *g* and *h* draw vertical projectors to view (*b*) intersecting the arcs *e* and *f* in the points *i*, *i'* and *j*, *j'*, respectively. Horizontal projectors drawn from these points to the lines *xx* and *ee'*, view (*a*), locate the points *j*, *i*, *j* on the lower end of the hole, and the points *j'*, *i'*, and *j'* on the upper end of the hole. Connect each series of points by arcs, as shown.

70. The opening *a*, Fig. 29, represents the opening *a* shown in Fig. 28 (*a*). The cross-section *EF* on the plate gives the distance from center to center of the holes drilled through the bottom of the groove *b*, Fig. 29 (*a*), as $\frac{5}{8}$ inch. Draw this

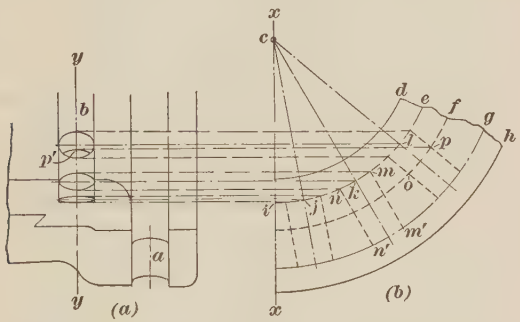


FIG. 29

view according to the dimensions on the plate and draw the center line *yy* through the center of the groove *b*. In view (*b*) draw the center line *xx* and with *c* as center draw arcs through the points *d*, *e*, *f*, *g*, and *h* with radii equal to $1\frac{1}{2}$, $1\frac{3}{4}$, 2, $2\frac{7}{16}$, and $2\frac{5}{8}$ inches, respectively. Set off the distance *ij* equal to $\frac{5}{16}$ inch and the distances *jk* and *kl* each equal to $\frac{5}{8}$ inch. Draw radial lines from *c* through *j*, *k*, and *l* and draw the sides of each hole, such as *mm'* and *nn'*, parallel to its respective center line and $\frac{3}{8}$ inch apart. Project the points *j*, *k*, and *l* to the center line *yy* to obtain the center lines of the holes in view (*a*). Project points such as *m* and *n* to the line *yy* to locate the upper and the lower point in the ellipse that represents the upper edge of a hole. The ellipses are drawn by means of circular arcs. It is to be noted that in the hole with the

center line *cl*, the arc *op* shows the line of junction between the babbitt lining and the cast-iron shell. As the point *p* and the adjacent portion of the circular line of junction appears at *p'* in view (*a*), an arc must be drawn also through the latter point, parallel to that defining the upper edge of the hole.

71. The construction, Fig. 30, applies to the right-hand end of Fig. **3,** which shows a plan of the groove *b*, Fig. 29. As the method of locating and defining the shape of the discharge holes corresponds entirely with that shown in Fig. 29, any further explanations will not be necessary.

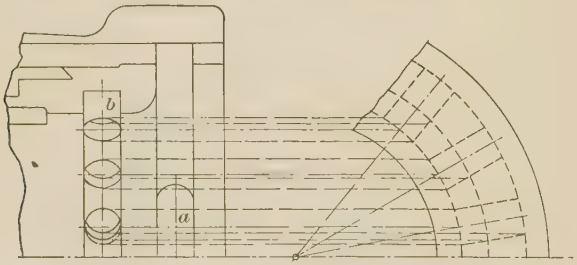


FIG. 30

72. Detail Sections.—In the detail longitudinal section of the top half of the bearing, shown in Fig. **4,** the line representing the inner face of the babbitt should be located $1\frac{1}{4}$ inches above the bottom border line. The right-hand end of the bearing is drawn $4\frac{3}{4}$ inches from the right-hand border line. The cross-section, Fig. **5,** taken on the line *IJ*, Fig. **2,** serves mainly the pupose of showing the construction of the tongue and groove by which the bearing halves are held in alinement. The center line should be drawn 1 inch above the bottom border line, and the inner face of the babbitt lining $6\frac{1}{2}$ inches from the left-hand border line. Leave a space of $2\frac{1}{8}$ by 5 inches in the lower left-hand corner for the description of the parts. After the outlines of the parts are inked in, the sectioning may begin, particular care being taken to have the lines on the sectioned babbitt lining equally spaced.

Plates 1021 to 1024, inclusive, are to be traced in ink on tracing cloth.

PLATE 1022, TITLE: ASSEMBLY AND DETAILS OF HOUSING

73. Construction of Housing.—The bearing, Plate 1021, is shown assembled in its housing on Plate 1022. This plate is to serve the double purpose of an assembly drawing and a detail drawing of the housing. The plate should be studied

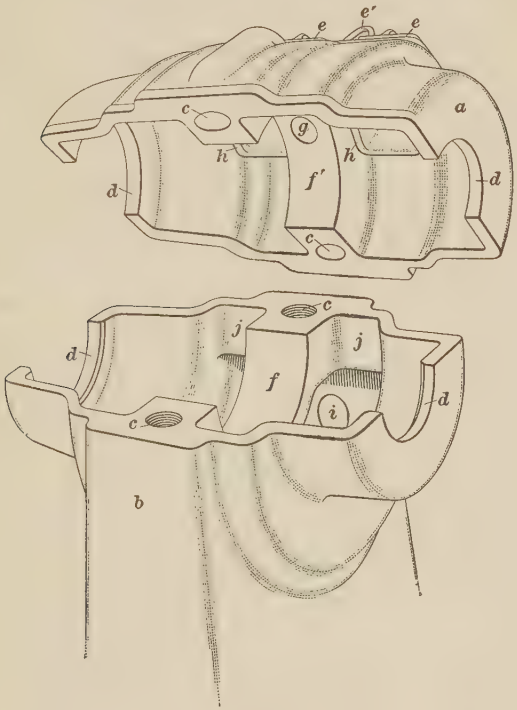
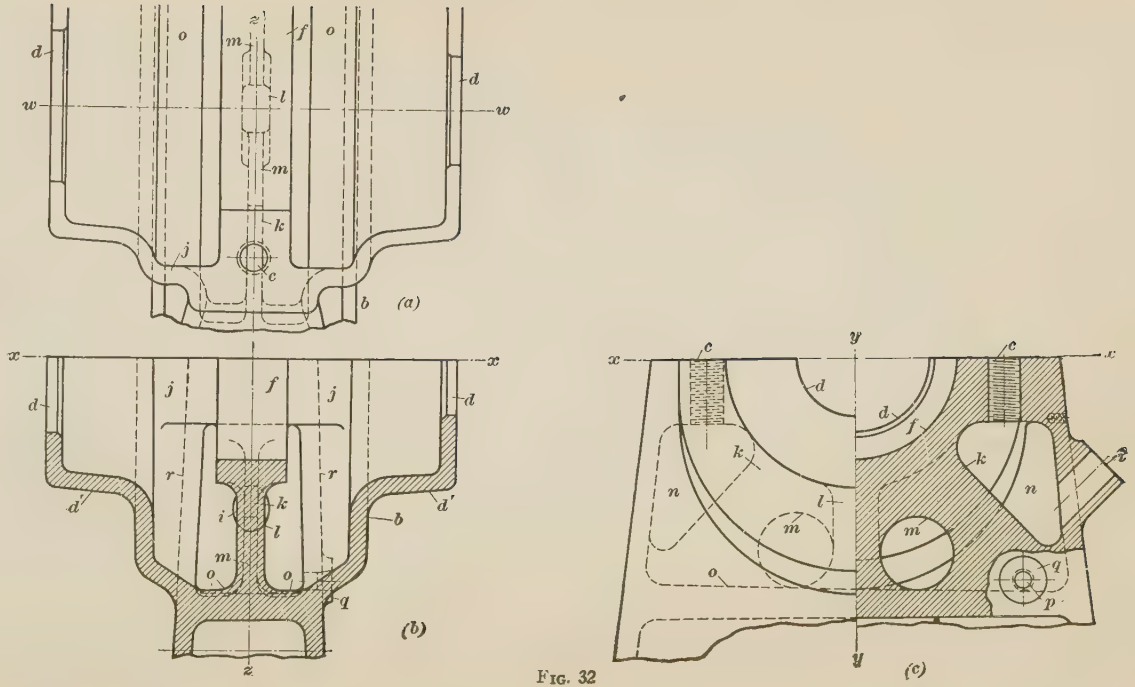


FIG. 31

in conjunction with Figs. 31 and 32, which show the housing separate from the bearing. Fig. 31 is a perspective view of the upper part of the housing and the housing cap. In attempting to visualize the assembly views, considerable aid will be obtained from Figs. 22 and 23.

74. As far as possible, similar reference letters are used for corresponding parts in Figs. 31 and 32. In Fig. 31, the hous-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m
o
o
q
(b)
z
x
c
y
c
x
d
d
f
k
k
n
n
l
m
m
o
q
p
z
y
(c)

FIG. 32

ing cap *a* is shown raised to disclose the internal features of the cap and the upper portion of the pedestal *b* that constitutes the housing proper, besides serving as an oil reservoir. In both parts are holes *c* for the bolts by which the cap *a* is fastened to the pedestal, and symmetrical halves *d* of the bores through which the shaft projects.

The oil-hole covers are shown at *e*, and at *e'* the lifting link by which the cap may be raised. The flange halves *f* and *f'* serve to support the bearing and limit its motion, the hole *g* in the half *f'* receiving the steady pin *n*, Fig. 23, that prevents rotation of the bearing. At *h* in the cap are shown the lower flange-shaped extension of the oil holes, closed above by the covers *e*. Through the opening *i* the oil level may be observed and additional oil poured, when necessary. Attention is called to the junction between the central flange *f* and the horizontal flanges *j*.

75. Of the detail views, Fig. 32, (*a*) is a plan of the housing in which the lower part of the pedestal is shown broken away, as indicated by the broken lines at the upper and lower side of the view. This plan represents the lower half of the perspective view, Fig. 31, similar reference letters indicating corresponding parts. View (*b*) is a longitudinal section, taken on the line *ww*, view (*a*). Of the two combined half-views in view (*c*), that at the left of the center line *yy* is an end view of the housing, and that at the right a cross-section, taken on the line *zz*, view (*b*).

The intersecting center lines *ww* and *zz* divide the plan, Fig. 32 (*a*), into four nearly symmetrical parts, of which the lower left-hand one is shown as the left-hand half of the plan, Fig. **3,** Plate 1022. On the same plate, Fig. 32 (*b*) is shown as the lower half of the housing in Fig. **2.** The combined half-views, Fig. 32 (*c*), correspond with the portion shown below the center line *xx*, Fig. **1,** Plate 1022.

76. The plan, Fig. 32 (*a*), is self-explanatory, when studied in conjunction with Fig. 31. Some explanations are needed of the parts located below the flange *f* in Fig. 32 (*b*) and (*c*). As seen from view (*b*), the flange *f* is supported by the web *k*,

of which the central portion is strengthened by the vertical rib *l*. As the web divides the reservoir into two chambers, the necessary communication between them is established by means of the circular apertures *m*, view (*c*). The web *k*, if continued clear across, would obstruct the opening *i*, hence the triangular apertures *n* are provided symmetrically on both sides of the center line *yy*.

The floor *o* of the reservoir, view (*c*), slants to the right so that the oil will flow toward the hole *p*, when the reservoir is to be drained of oil. As the hole is to be threaded to receive a drain cock, the wall is thickened at this place by the boss *q*.

77. End View and Cross-Section.—Begin Plate 1022 by drawing the horizontal center line *xx* across the plate at a distance of $5\frac{3}{16}$ inches above the lower border line. Perpendicular to this line draw the vertical center line *yy* for Fig. **1** at a distance of 5 inches from the right-hand border line. This view is a combination of two half-views, of which that at the left is a full end view and the other a cross-section, taken at the center of Fig. **2.** The end view corresponds with the upper part of the assembly end view, shown near the top of the plate. It is seen that these views show a *pattern parting line*, indicating that the pattern is to be made in two parts to be joined at the parting line. The division is made at this place to facilitate the making of the lower part of the pattern, which is hollow. The cross-web forming the bottom of the oil reservoir is located $\frac{7}{8}$ inch above the parting line at the line *yy*. Figs. **1, 2,** and **3** are drawn half size and the assembly views one-eighth size.

78. Begin Fig. **1** by drawing lines that are common to both half views, such as the outline of the shaft, represented by a circle $2\frac{7}{8}$ inches in diameter, according to Fig. 33, which is inserted in the text to furnish some detail dimensions of the shaft. An oil ring may now be shown suspended from the shaft. The inside diameter of this ring, part **11,** is 6 inches, as shown in the double-size detail placed in the lower left-hand corner of the plate. Any dimensions omitted from Fig. **1** must be looked for in one of the other views.

At a distance of $4\frac{1}{2}$ inches above the center line *xx* draw a short horizontal to represent the face of the central boss on top of the housing cap. Limit the length of the face by verticals drawn $4\frac{3}{8}$ inches apart; round off the corners formed by arcs of $\frac{1}{8}$-inch radius. At a distance of 4 inches on each side of the center line *yy* draw verticals to serve as center lines for the bolts, part **9.** Then, at a distance of $3\frac{3}{4}$ inches above the center line *xx*, draw horizontals across the bolt center lines to represent the upper faces of the bosses on which the bolt heads rest. Make the spot faces 2 inches in diameter.

79. The slanting sides of the cap and the pedestal, Fig. **1,** may now be drawn. The annexed note states that these sides

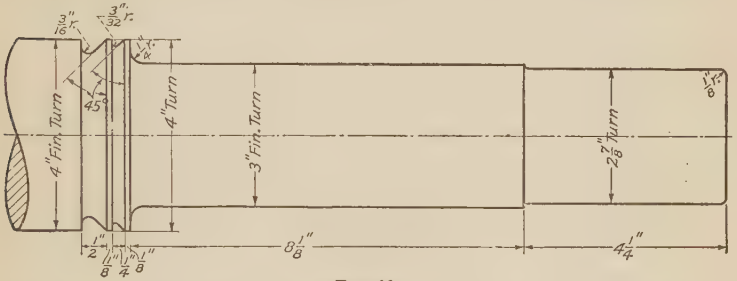


FIG. 33

have a taper of $\frac{1}{8}$ inch per inch. To make this taper sufficiently accurate, draw at any place near this view a vertical line 6 inches long and intersect its upper end with a horizontal line. Set off on this line on each side of the point of intersection a length of $6 \times \frac{1}{8} = \frac{3}{4}$ inch. Straight lines connecting the points, thus found, with the lower end of the vertical will give the correct slant for each side of the pedestal. To draw these sides, set off on the center line *xx*, a distance of $5\frac{1}{2}$ inches on each side of the center line *yy*. Through the points thus found draw lines parallel to the slanting lines just drawn.

The beadlike projection at the base of the cap is $\frac{3}{8}$ inch thick. As shown at the right-hand side of the cap, the head projects $\frac{3}{16}$ inch beyond the cap and its slanting side is parallel to the adjoining side of the pedestal. Round off with arcs of $\frac{1}{8}$-inch radius the corners formed by the upper corners of the

housing cap and the spot faces for the bolt heads, and insert fillets at the inner corners of these faces, as shown. The bolt heads are drawn to correspond with the standard head, described in *Mechanical Drawing*.

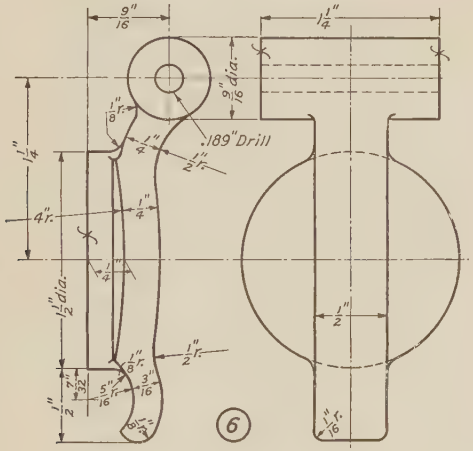
80. In the end view, Fig. **1,** draw the various arcs that define the outline of the housing cap, such as the arc of $5\frac{5}{8}$-inch radius with the center located $1\frac{1}{8}$ inches below the center line *xx*. A smaller arc has a radius of $4\frac{3}{4}$ inches and its center $\frac{1}{2}$ inch below the line *xx*. The semicircles representing the end faces of the housing cap and the pedestal, respectively, combine to form a circular face, 7 inches in diameter, as shown in Fig. **2.** The arcs located below the line *xx* are drawn in the same manner. The semicircle indicating the end bore for the shaft to pass through may now be drawn with a radius of $1\frac{17}{32}$ inches.

Indicate by dotted lines the positions of the two oil openings in the cap, Fig. **1.** Each hole has tapering sides, the opening being $3\frac{1}{2}$ inches wide at the top and $3\frac{5}{8}$ inches at the bottom. As seen from Fig. **2,** the openings are $1\frac{7}{8}$ inches deep. The shape of the lower edge of each opening is defined by a dotted arc of $3\frac{1}{4}$-inch radius. Round off the lower end of the wall with an arc of $\frac{3}{32}$-inch radius; tangent to this arc draw a line inclined at 45° to the inner wall, as shown. This tangent is joined to the inner side of the cover, which is here $\frac{1}{2}$ inch thick, by a fillet of $\frac{3}{16}$-inch radius.

81. The sectional half-view of the housing and bearing, Fig. **1,** may now be completed, for which purpose some of the dimensions given in Fig. **2** are to be used, such as the diameter of the central bore of the bearing, which is $5\frac{1}{2}$ inches. The diameter of the babbitt lining and the dimension of its oil recess, as well as a number of other details, may be obtained from Figs. **1** and **2,** Plate 1021. This half-section cannot be fully understood before Fig. **3,** Plate 1022, is consulted, which is a combination half-plan of the housing and the cap. The portion of the plan situated between the horizontal center line and the top border line are omitted, as it is symmetrical with the portion shown. On the left of the center line *zz* is a

quarter-plan of the housing, integral with the upper part of the pedestal. This plan shows the reservoir *k* and the flange *j*, illustrated in the perspective view, Fig. 23.

At the right of the center line *zz*, Fig. **3,** is shown a quarter-plan of the cover, part **2.** This view shows a plan of one of the spot-faced bosses for a bolt head; also, the central boss with one of the oil holes and a portion of the lifting link. The beadlike projection, previously referred to, is shown in plan



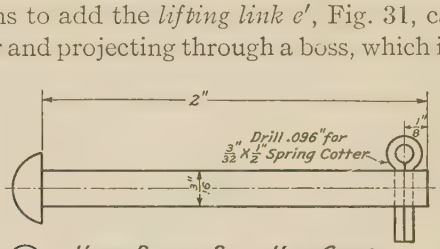
SIGHT HOLE COVER
ONE REQ'D. THUS-C.I. PATT. NO. 1020-6

FIG. 34

82. Proceeding again with the half-section in Fig. **1,** it is to be noted that the sectioned portion below the bearing represents the central flange, web, and aperture, corresponding to the parts *f*, *k*, and *m*, Fig. 32 (*c*). As seen from Fig. **2,** the major portion of the web is $\frac{3}{8}$ inch thick, and the rib *l*, Fig. 32 (*c*), is indicated as being $\frac{3}{4}$ inch thick. In Fig. **1** it is seen to extend only for a distance of $\frac{5}{8}$ inch on either side of the center line *yy*. The circular opening, 2 inches in diameter, is drawn tangent to the $\frac{5}{8}$-inch rib and to the slanting bottom line of the oil reservoir, the bottom being $\frac{3}{4}$ inch thick at the center line *yy* and $\frac{5}{8}$ inch thick near the right-hand wall. At this place a portion of the side wall with the drain-cock hole is shown in full.

At the lower end of the bolt, part **9,** is a triangular opening connecting with a sight hole through which the level of the oil may be seen. This sight hole is provided with a cover, part **6,** hinged to a bracket, part **7,** by means of a hinge pin, part **12.** The detail drawings of the cover and the bracket with its pin are shown in Figs. 34 and 35, respectively.

It remains to add the *lifting link e'*, Fig. 31, cast in the top of the cover and projecting through a boss, which is $\frac{1}{8}$ inch thick,



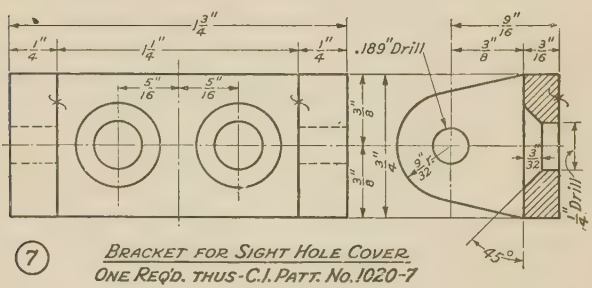


FIG. 35

1 inch wide, and $1\frac{1}{8}$ inches long. The thickness of the link is not given on the drawing. The link is made of $\frac{1}{4}$-inch steel wire, bent into shape, and mounted in the mold so as to extend for a distance of $1\frac{11}{16}$ inches above the face of the main boss.

83. Longitudinal Section.—In proceeding to draw the longitudinal section, Fig. **2,** of the housing, erect the vertical center line *zz* $3\frac{7}{8}$ inches from the left-hand border line. Project from Fig. **1** the horizontal faces and lines common to both views, such as the top and bottom faces of the housing and the bearing. Locate the positions of the two end faces of the housing by verticals drawn at a distance of $5\frac{1}{2}$ inches

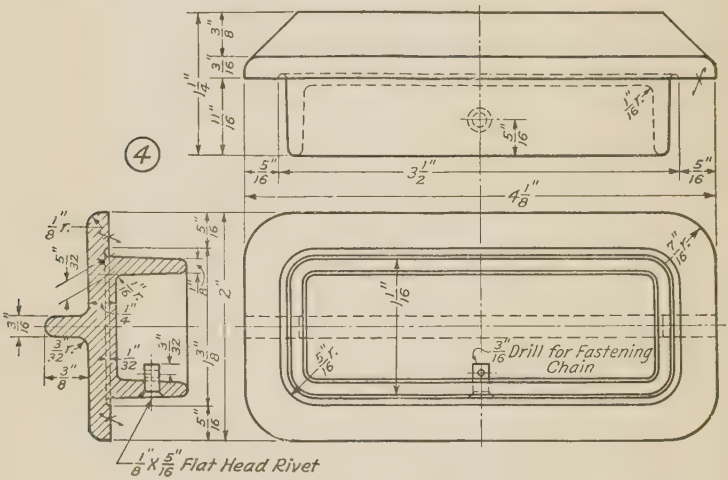
from the line *zz*. Set off on these verticals, on each side of the center line *xx*, a length of $3\frac{1}{2}$ inches and through the points obtained draw lines to represent the tapering ends of the housing, corresponding with the lines *d'*, Fig. 32 (*b*). Each of these lines tapering $\frac{1}{16}$ inch per inch, set off this taper by means of the method described with reference to Fig. **1.** In this case, however, a horizontal line 2 inches long will give a sufficiently accurate result. The vertical cross line at the end of this line will extend $\frac{1}{8}$ inch, to scale, on each side of the horizontal line.

Draw the side walls of the oil reservoir in the position specified and join them to the tapered ends of the housing by arcs of $1\frac{1}{8}$-inch radius. Locate the point at which the side walls and the bottom of the reservoir intersect, at a place $5\frac{3}{4}$ inches below the line *zz*, and draw the bottom face at an inclination of 30°, as shown.

Next, draw a horizontal 7 inches below the line *xx* to represent the lower side of the reservoir floor. Make this line 4 inches long, as shown; set off on the center line *xx*, on each side of the center line *zz*, a length of $1\frac{23}{32}$ inches. Of the points just set off, connect by a straight line the pair located on the same side of the line *zz* to obtain the tapered sides of the pedestal, shown in dotted lines. These lines correspond with those shown at *r*, Fig. 32 (*b*). Extend these lines to a point about 1 inch below the top of the cover, where they end in fillets $3\frac{3}{16}$ inches apart. Where the other ends of these lines intersect the slanting bottom faces of the reservoir floor, insert fillets of $\frac{3}{4}$-inch radius. Below the reservoir show a portion of the pedestal walls, which are $\frac{1}{2}$ inch thick.

84. Draw the housing cover, part **2,** with its oil holes, which have their center lines 2 inches from the line *zz*. The lower extensions of the walls of these holes, shown at *g*, Fig. 23, and at *h*, Fig. 31, have each a curved recess corresponding with that drawn with a radius of $3\frac{1}{4}$ inches in Fig. **1.** The top and bottom points of this recess must be projected from the latter view to Fig. **2** to obtain the positions and depth of the corresponding recesses. After the steady pin, part **10,**

and the lifting link are added, one of the oil-hole covers, part **4,** may be shown. The details of this part are shown in Fig. 36, and those of the oil-hole plug, part **5,** in Fig. 37. The drawing of the housing may be completed by showing the bores in the two ends. It is to be noted that the dash-and-dot lines represent the outer faces as being conical. The pattern is so made to insure a sound casting at this place; subsequently the faces are finished off as represented by the full lines.



OIL HOLE COVER.
2 REQ'D.-C.I. PATT. NO. 1020-4

FIG. 36

85. The bearing, part **1,** which is now to be drawn, is shown in Fig. **2** in a longitudinal section at the left of the line *zz* and in a front view at the right of this line. Instructions and dimensions required for drawing this part are given on Plate 1021. The only part not previously shown in a front view is the splash guard, represented as part **7,** Plate 1021, and shown there in plan, in Fig. **3.** The positions of the screws by which it is held in place are shown in Fig. **1** on the same plate, and in Fig. **2** on Plate 1022. The positions and shape of the oil drain holes near the right-hand end of the bearing are not expected to be drawn accurately, as they will assume the

correct shape, when drilled, irrespective of the drawing.

The drawing of the left half of the bearing is based on the details already provided on Plate 1021. After the babbitt lining is completed, the generator shaft should be added, the required dimensions being given in Fig. 33. The position of the shaft is fixed by that of the shoulder shown in contact with the end face of the babbitt lining, the lengths of the adjacent divisions of the shaft being set off from this shoulder.

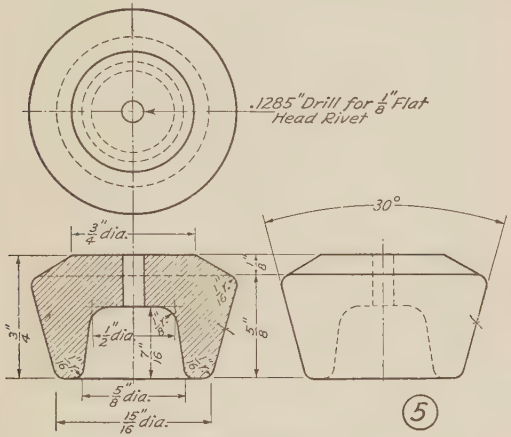


FIG. 37

The cross-section of the oil rings shown in this view is given in the detail found in the lower left-hand corner of the plate. The left end and top side of this detail section are drawn, respectively, 1 inch from the left-hand border line and $1\frac{5}{8}$ inches from the bottom one.

In the section of the bearing, an oil hole plug, part **5,** is indicated, the link chain connecting it with part 4 being drawn as shown.

86. Half-Plan of Housing.—The center line of Fig. **3** should be drawn $1\frac{1}{16}$ inches below the top border line. The total length of this plan view is 11 inches; intermediate lengths, and some of the diameters, may be obtained from Fig. **2.**

The position of the bolt center and the length and width of the boss are given in Figs. 1 and 2. The tapered end portions may be drawn parallel to corresponding parts in Fig. 2.

87. Assembly Drawing.—The assembly drawing consists of three views, the two at the left being a side view and a bottom view and the one at the right a front view. Draw a horizontal to represent the center line of the shaft $1\frac{1}{8}$ inches below the top border line. For vertical center lines of the side view and the front view, draw verticals $8\frac{3}{8}$ and $5\frac{3}{4}$ inches from the right-hand border line, respectively. The horizontal center line of the bottom view is $4\frac{1}{2}$ inches below the top border line.

As an assembly drawing is intended to supply only overall dimensions, the detail drawings must be consulted for the additional detail dimensions required in making the assembly views. Some explanations are needed for the pedestal base, as it is not previously shown. In order that the pedestal, when once alined in the shop, may occupy a correct position on the supporting bedplate at the place of erection, a $\frac{1}{2}$-inch dowel hole is drilled through each end of the base and into the bedplate, after which a dowel pin is driven into the hole. There are two bolt holes in each end of the base; but in the front view these holes are indicated only by their center lines to avoid confusion of lines. For a similar reason, the holes for the dowel pins are omitted from the side view. The dimension $\frac{7}{8}''$ *r*, placed in the front view a short distance above the base, refers to the radius of the arcs to which the pedestal corners are rounded off. This dimension must be read in conjunction with the note in Fig. 3, reading: "Blend into $\frac{7}{8}''$ r. at P.L." As in the latter view the corner is rounded off to a radius of $\frac{3}{8}$ inch the note indicates that this radius shall gradually be increased to a radius of $\frac{7}{8}$ inch at the parting line.

A space of $3\frac{9}{16}$ by 5 inches is set off in the upper right-hand corner for a descriptive list of the parts, a space of $\frac{1}{4}$ inch being allowed for each part.

PLATE 1023A, TITLE: SLIDING BRACKET
PLATE 1023B, TITLE: PILLOW BLOCK

SKETCHES APPLIED TO SHOP DRAWINGS

88. Purpose and Nature of Sketches.—When a new machine or one of its elements is to be made, the designer or the chief draftsman will usually convey his ideas of its main features to the draftsmen by means of a sketch, usually made freehand, sometimes by means of instruments. From this sketch the draftsman will make a preliminary assembly and then the detail drawings.

There are various kinds of sketches, depending on the branch of art or industry to which it is applied. A *sketch*, as applied to a mechanical drawing, is usually made according to the rules of orthographic projection, consisting therefore of two or more views. If the shape of the machine part is such as to require it, the purpose of the sketch may be better served by showing the part in a perspective view or by means of a view made according to the rules of isometric drawing.

Sometimes, when a duplicate is to be made of a machine that cannot be removed from its place of operation, it may be necessary or more convenient to show the construction of the machine entirely by means of freehand sketches made on the spot. No matter for what purpose or in what manner the sketch is made, it must be such that the draftsman will be able to interpret it and readily apply it to the making of a mechanical drawing.

89. Object of Drawing Plate.—The object in introducing Plate 1023 is to provide some experience in making drawings from sketches. While the sketches may be made according to the rules of mechanical drawing so far as arrangement of views and relative positions of the detail parts are concerned, they may, nevertheless, be misleading as to the actual shape and relative size of the parts. If a sketch is not always a reliable guide in the latter respects, the draftsman must depend mostly on the given dimensions while making the drawing, the sketch simply showing to what parts the dimensions apply.

SKETCHES OF SLIDING BRACKET

90. General Construction.—In the sketch, Fig. 38, a side view of a sliding bracket is shown in (*a*), and an end view in (*b*). The base *a* of the bracket has a dovetailed recess *b* fitting a correspondingly shaped slide on which the bracket is supposed to move longitudinally. The amount of play between the base and the slide may be adjusted by means of a number of headless setscrews, to be inserted in the holes *c*, drilled through the side flanges of the base. Cast in one with the base is a bearing *d*, provided with a bore *e* of 1 inch diameter. At the outer end of the bearing there is a circular flange *f*, projecting partly below and beyond the base *a*. The hole *g* in the base is intended for the insertion of a suitable device for lubricating the slide.

91. Number and Kind of Views Employed in Sketches. When a draftsman is furnished with sketches containing a number of views from which a drawing is to be made, it is not to be assumed that the kind of views, their number, and their arrangement are to be followed in the drawing made from them. Rather are they in many cases, as, for instance, Figs. 40 and 41, to be considered as elements with which to build up the drawing. Often the sketch contains a number of views, made purposely to show more clearly some details that are to form part of the main views in the drawing. Which views to use and whether other views are to be constructed by means of them, the draftsman will have to decide.

INSTRUCTIONS FOR DRAWING SLIDING BRACKET

92. Space Allowed on Plate.—From the fact that Plate 1023 is to contain two sets of views drawn from sketches, it is necessary to allot the required room for each set. In drawing the views, one of the narrow sides of the plate will be considered as the top. After the usual border lines, 13 by 17 inches, are drawn, a horizontal dividing line is drawn 9 inches above the lower border line. Within this space the views of the sliding bracket are to be drawn, the remaining space of 8 by 13 inches being reserved for the views of the pillow block.

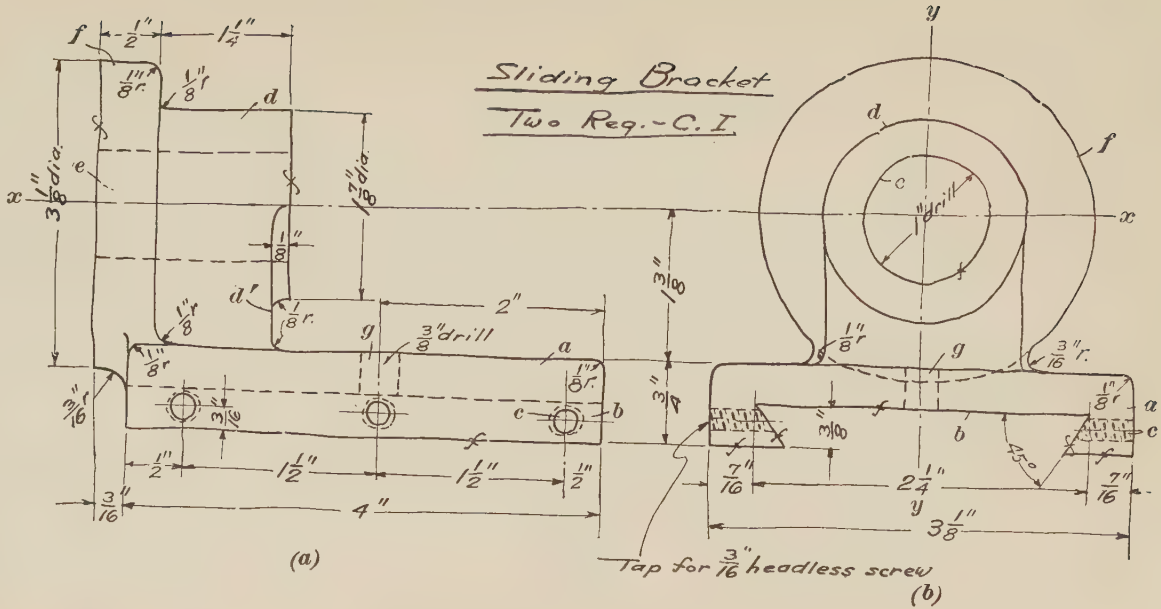

Sliding Bracket
Two Req.-C. I
(a)
(b)
Tap for 3/16" headless screw
3/8" drill
drill
45°

FIG. 38

93. Arrangement and Drawing of Views.—The arrangement of the views on the drawing plate is indicated in Fig. 39. Draw the center line, corresponding with *xx*, Fig. 38, $2\frac{3}{4}$ inches above the lower border line. Draw the left-hand face of the flange *f*, view (*a*), $1\frac{1}{2}$ inches from the left-hand border line, and the center line *yy* of view (*b*) $3\frac{1}{8}$ inches from the right-hand border line. Complete these views by means of the data given in the sketches. It is to be noted that the reference letters used in the text refer to the sketches, all reference letters being omitted from the plate. The views are drawn full size.

94. As a means of gaining experience in making additional views from those already drawn, it is required to draw a plan of the bracket and also a longitudinal section taken on the line *yy*, view (*b*), Fig. 38. The horizontal center line of the plan, to be drawn above the side view, should be $2\frac{5}{8}$ inches below the dividing line. The line to represent the left-hand face of the flange *f* is projected up from the side view to fix the position of the plan in a lateral direction. To fix the position of the longitudinal section, locate the horizontal center line *zz*, corresponding to the line *xx*, view (*a*), $2\frac{1}{16}$ inches below the dividing line, and draw the vertical line, corresponding with the left-hand face of the flange *f*, $6\frac{1}{8}$ inches from the right-hand border line.

In beginning to draw the plan, set off above and below its center line one-half the width of the base, or $3\frac{1}{8} \div 2 = 1\frac{9}{16}$ inches. Then project up from the side view the line that represents the right-hand end of the base, the resulting figure being a rectangle $4\frac{3}{16}$ inches long and $3\frac{1}{8}$ inches wide. Complete the flange *f* and the bearing *d* and draw the left-hand end of the base, hidden by the flange. Indicate the shape of the dovetail recess by dotted lines drawn at the distance apart given in the end view.

Locate the positions of the center lines of the setscrew holes by vertical lines projected from the side view. In the plan, the inner slanting ends of these holes will appear as two series of circles, each series having a common horizontal center line,

whose position may be ascertained from the end view. Draw the holes in dotted lines and indicate the depth of the thread by two parallel lines drawn outside the sides of each hole at the

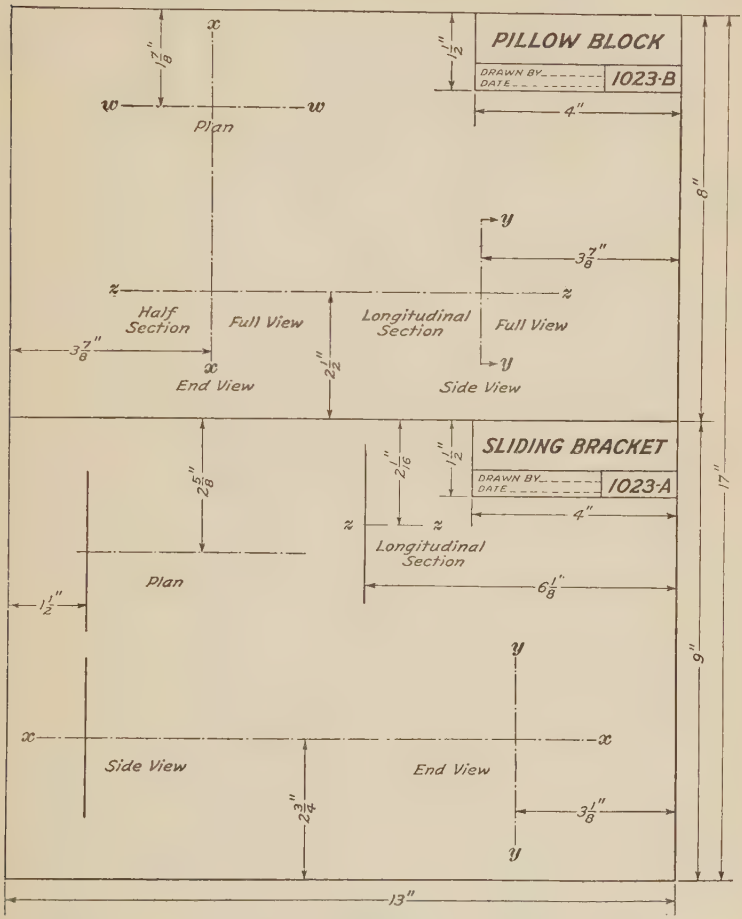


Fig. 39

required distance. At the inner end a larger, dotted circle will represent the root of the thread.

The face d' of the bearing, view (a), must be shown in the plan as a dotted line. At each end of the latter a short line, drawn at an angle of 45° to the face d', indicates the line of

intersection of the fillets on adjoining sides at the base of d'. Only the two following dimensions need be shown in this view: The distance of 2 inches between the right-hand end of the base and the center of the lubricator hole. At this hole the note $\frac{3}{8}''$ drill should be printed and connected to the hole by an arrow. In the sketch this note is shown in view (*a*), but should preferably refer to the full-line circle in the plan.

95. The outline of the longitudinal section of the bracket, now to be drawn, corresponds entirely with that of the side view, Fig. 38 (*a*). Care must be taken to show the correct cross-sectional area of the parts shown in section, the required information being obtained from the plan and the side view. This section should contain a dimension giving the total length of the dovetailed recess, and also the distance through which the end face of the flange projects beyond the recess. The dimensions $\frac{1}{2}$ and $1\frac{1}{4}$ inches, placed above Fig. 38 (*a*), should preferably be inserted in the bore shown in the longitudinal section and referred to the dotted line of the flange drawn across the bore. In all views, finish marks should be shown on the faces so marked in Fig. 38 (*a*) and (*b*). In the upper right-hand corner of this part of the plate, lay off space for the title and number of the plate, as shown in Fig. 39.

SKETCHES OF PILLOW BLOCK

96. Main Features of Pillow Block.—A *pillow block* is a bearing intended to support one end of a revolving shaft. The bearing is divided into two parts; a *base* fastened to the frame of the machine or to a separate foundation, and a *cover* that may be removed to permit inspection of the bearing and its adjustment for wear.

97. Description of Base.—The base of the pillow block is shown in Fig. 40, in which (*a*) is an end view, (*b*) a plan, and (*c*) a side view. These views being symmetrical on both sides of the center lines *ww*, *xx*, and *yy*, respectively, it will be found that in some views certain construction features are shown only on one side of the center line, it being understood that these features exist also on the other side, but are omitted to save

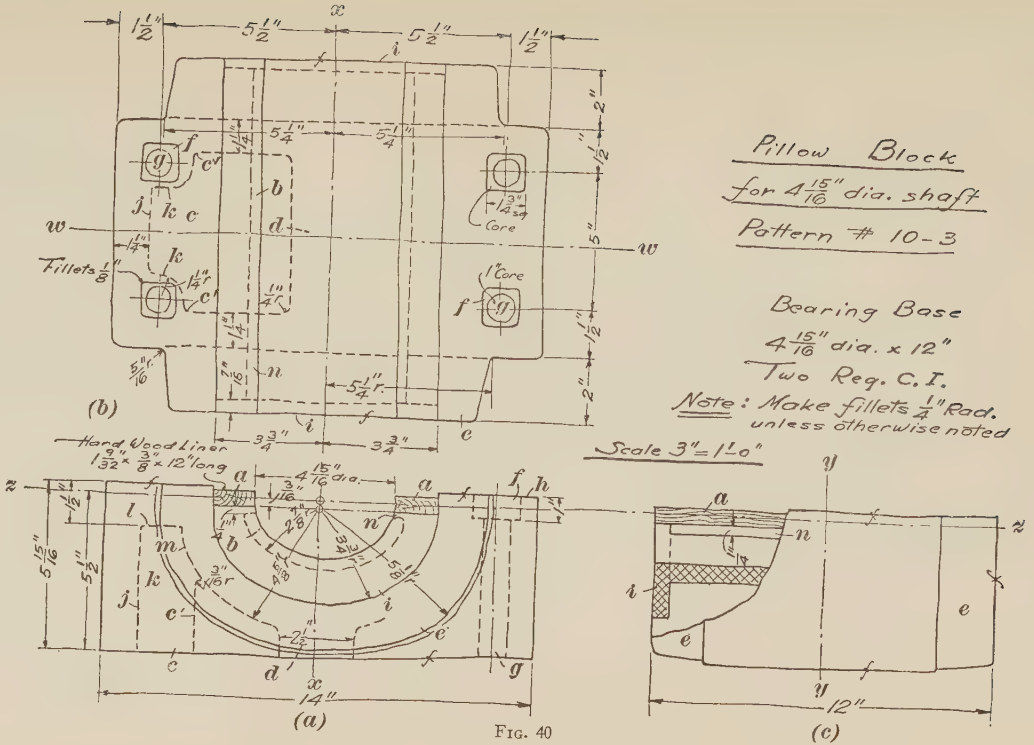

Pillow Block
for 4 15/16" dia. shaft
Pattern # 10-3
Bearing Base
4 15/16" dia. x 12"
Two Reg. C.I.
Note: Make fillets 1/4" Rad.
unless otherwise noted
Scale 3"=1'0"
Fillets 1/8"
Hard Wood Liner
1 9/32" x 3/8" x 12" long
Core
1" Core
3/4" Core
(a)
(b)
(c)
14"
12"

FIG. 40

time. However, in the drawing made from the sketches, such omissions are not permissible.

As seen from Fig. 40 (*a*), the horizontal center line *zz* passes through the center of the bore of $4\frac{15}{16}$ inches diameter in which the shaft is supposed to rest. On each side of this bore there is a hardwood liner *a*, $\frac{3}{8}$ inch thick, so placed that one of its side faces constitutes a portion of the bearing surface, which otherwise mostly consists of babbitt poured into a recess *b*, provided for the purpose. On each side of the center line *xx* there is a recess *c*, also shown in view (*b*), which serves to reduce the weight of the base. These recesses are separated by a rib *d*, as shown in views (*a*) and (*b*). The base proper, which is of rectangular shape, has at each end a tapering extension *e*, as shown more clearly in views (*b*) and (*c*).

98. The cap, Fig. 41, and the base, Fig. 40, are fastened to each other and to the supporting frame by means of four stud bolts, not shown. Each bolt has near its upper end a square shoulder fitting into one of the recesses *f*, Fig. 40 (*a*) and (*b*), so as to prevent the bolt from turning while a nut is screwed on its lower end to fasten the base to the frame, or while another nut is screwed on its upper end to fasten the bearing cover to the base. One of the bolt holes in the base is shown at *g*, view (*a*); in view (*b*) a plan of the holes is shown in the center of each recess *f*. The taper of the extensions *e* is indicated by the radii $5\frac{1}{8}$ and $5\frac{1}{4}$ inches, given, respectively, in views (*a*) and (*b*). It is seen from the dimensions $5\frac{1}{2}$ and $5\frac{15}{16}$ inches, placed at the left of view (*a*), that the upper face *h* of the base is $\frac{7}{16}$ inch above the center line *zz*. The bottom of the recess in which each liner *a* rests is $\frac{3}{16}$ inch below the line *zz*.

99. The babbitt lining has at each end a flange *i* of $3\frac{3}{4}$-inch radius, as shown in Fig. 40 (*a*), (*b*), and (*c*). These flanges extend to the bottom of the recesses for the liners *a*; but the main body of the lining stops $\frac{1}{4}$ inch below this recess, as shown in view (*a*). This is also shown in the partial section of view (*c*), the $\frac{1}{4}$-inch rib *n* of the casting projecting through the

babbitt lining to prevent it from making an angular motion in the direction of the revolving shaft.

The bore of the bearing is $4\frac{15}{16}$ inches in diameter, as stated in the title, Fig. 40. The point of intersection of the axes *xx* and *zz* is the center of the bore. It is, however, important to note that the dotted arc representing the lower face of the babbitt lining, is not concentric with the bore, being drawn with a radius of $2\frac{7}{8}$ inches from a center located $\frac{3}{16}$ inch below the center of the bore. This is to provide more babbitt below the shaft where the wear is the greatest. The arcs representing the tapering extension of the base are also struck from the lower center.

100. Description of Cap.—Separate views of the bearing cap are shown in Fig. 41, in which an end view, partly broken away, is shown in (*a*), a plan in (*b*), and a side view in (*c*). Center lines, corresponding with those shown in Fig. 40, have similar reference letters. On each side of the cap there is a flange *a* with bolt holes *b* alining with the holes *g* in the base, Fig. 40 (*a*). The flanges are strengthened by the ribs *c*, shown in all the views in Fig. 41. As seen more clearly in view (*b*), the upper face of the flanges is spot-faced around the holes *b* to a radius of $1\frac{3}{8}$ inches to provide a level surface for the nuts screwed down on the upper end of the stud bolts. The line of intersection of the spot-faced surface with the top of the cap is indicated by the arcs *d* in all the views.

It is seen from Fig. 41 (*c*) that the cap tapers from the center line *yy* toward each end, of which the outer portion conforms, as to diameter and taper, with corresponding portions of the base. The amount of taper is determined by the radii $5\frac{1}{2}$ and $5\frac{1}{8}$ inches, as given in Fig. 41 (*a*).

101. On each side of the bore of $4\frac{15}{16}$ inches diameter, there is a tongue *e*, Fig. 41 (*a*), fitting into the recess containing the liner *a*, Fig. 40 (*a*). Consequently, when the cover is fastened down it not alone forces the liners into place, but prevents the cover from moving out of alinement with the base. When, as a result of wear, the vertical diameter of the bore is increased, the liners are filed down correspondingly to allow the tongues *e*

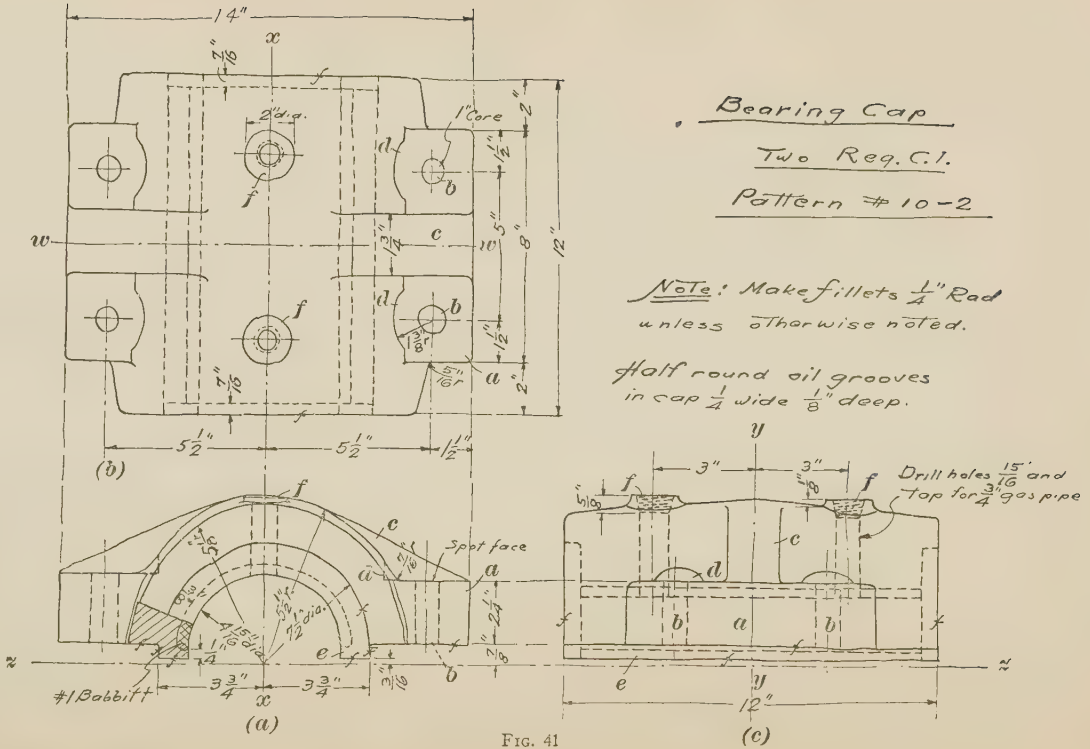

Bearing Cap
Two Req. C.I.
Pattern # 10-2
NOTE: Make fillets 1/4" Rad unless otherwise noted.
Half round oil grooves in cap 1/4 wide 1/8" deep.
Drill holes 15/16 and Top for 3/4" gas pipe
Spot face
#1 Babbitt
(a)
(b)
(c)

FIG. 41

to descend farther into the recesses and thus make the vertical diameter of the bore equal to the horizontal one. As seen from the partial section, Fig. 41 (*a*), there is also in the cap a narrow tongue, $\frac{1}{4}$ inch wide, projecting through the babbitt to hold it in place.

The vertical holes drilled through the bosses *f* and passing through the babbitt lining serve as passages for the lubricant delivered by a grease cup screwed into the upper end of these holes. These ends are tapered $\frac{3}{4}$ inch to the foot and are provided with a pipe thread. A detail view of the threaded portion of the hole with approximate dimensions is shown in the detail section, Fig. 42. Depending on the purpose for which the bearing is used, a suitable babbitt is chosen. The kind employed in this case is designated in view (*a*), Fig. 41, as No. 1.

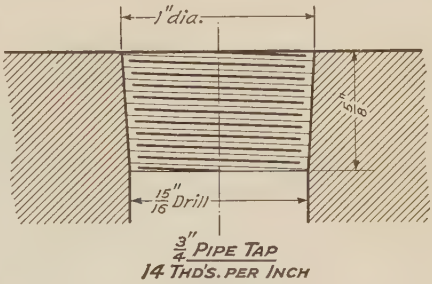


Fig. 42

INSTRUCTIONS FOR DRAWING PILLOW BLOCK

102. Number and Arrangement of Views.—It is assumed that the sketches, Figs. 40 and 41, are made from a pillow block installed in a place where a drawing board and instruments could not be used. To obtain the necessary details of construction, the cover was removed and the cover and the base were drawn separately. As the drawing on the plate is to be an assembly, some of the sketched views are combined, so that only three views will be made instead of the six shown in the sketches. In each view the cover is to be shown in place on the base, but without the stud bolts.

Draw, according to Fig. 39, the assembly views of the pillow block on the upper portion of the plate, arranging the views in the positions indicated by the center lines, these positions corresponding with those of the views in Figs. 40 and 41. Draw the vertical center lines *xx* and *yy*, Fig. 39, at a

distance of $3\frac{7}{8}$ inches from the left-hand and the right-hand border line, respectively. The horizontal center lines *ww* and *zz* are drawn $1\frac{7}{8}$ and $2\frac{1}{2}$ inches, respectively, from the upper border line and the dividing line.

103. Instructions for Drawing the Assembly.—Draw the views to a scale of 3 inches = 1 foot. Corresponding in position with Figs. 40 (*a*) and 41 (*a*), draw an end view of the complete bearing in the position indicated in Fig. 39. Show the cover in position with its tongues resting on the liners, but omit the stud bolts and the nuts. At the left of the center line *xx* show a half-section of the pillow block, taken on the center line *yy*, view (*c*), looking in the direction of the arrows. The babbitt lining in the cap and in the base must be shown in section in the manner shown in the partial section, Fig. 41 (*a*). The bolt holes with their recesses must be indicated in the base by dotted lines; likewise the corresponding holes in the cap. Show in the cap also the sides of the lubricating hole by means of a dotted line on each side of the center line. A feature that will require some attention is the recess *c* in the base; this recess is to be shown in full in the half-section.

To ascertain the correct shape of the sectioned parts that surround this recess, it is necessary to consult Fig. 40 (*a*) and (*b*). The latter view shows that the line *ww*, on which the section is taken, passes through the left-hand wall *j* of the base, which at this place is $1\frac{1}{4}$ inches thick. This wall, as well as the $1\frac{1}{2}$-inch layer of metal *l* above the recess, as shown in view (*a*), must be sectioned. The right side of the recess is defined by the curved face *m* of the bearing proper. It follows that the three lines, *j*, *l*, and *m*, Fig. 40 (*a*), will define the outline of the recess *c*. In the rear of this recess is seen the corner *c'* where the curved wall of the bolt hole intersects the rear wall of the recess. While the method of drawing each view will be described separately, it is to be understood that in all the views corresponding parts are to be drawn successively.

104. The plan of the pillow block, which will be drawn above the end view, is to be a combination of two half-plans,

that at the left of the center line *xx* showing the base with the cover removed, and that at the right showing a half-plan of the cover with the underlying portion of the base indicated in dotted lines. The recess *c* is shown on both sides of the center line in dotted lines. The liners are to be omitted from this view.

105. The side view of the pillow block is to be drawn on the center lines *yy* and *zz*. In this view, which also includes the cover, the portion at the left of the center line *yy* is to be shown in a half-section, taken on the line *xx* of the end view. In the half-section, the upper and the lower babbitt lining are shown in section, including the semicircular flanges *i* at the left end. The liner is shown in place, and above and below the liner must be shown the projecting tongue or rib, indicated at *n*, Fig. 40 (*a*), (*b*), and (*c*), and at *e* in Fig. 41 (*a*) and (*c*). In this half, one of the lubricating holes is shown in section, the information needed for drawing the threaded portion being obtained from the detail view, Fig. 42.

In this side view, the side flange *a* on the cover, Fig. 41 (*c*), must be shown partly in full and partly in dotted lines, depending on which side of the center line *yy* the portion is located. The bolt holes are both shown in dotted lines.

To avoid complications, the recesses *c*, shown in Fig. 40 (*a*) and (*b*), are to be omitted from the side view. The curved recesses *d*, Fig. 41 (*a*), (*b*), and (*c*), produced by spot-facing the flanges *a* for the bolt nuts, must be shown in dotted lines in the half-section of the side view and in full lines in the other half. The height and length of one of the recesses *d* must be measured in Fig. 41 (*a*) and (*b*). In view (*b*) the arc drawn with a radius of $1\frac{3}{8}$ inches will cut the line at which the rounded surface of the cover intersects the top face of the flange *a*. One-half of the length of the arc *d* thus obtained is set off on each side of the center lines of the bolt holes *b* in the side view. The height of the recess being indicated by the dotted line at *d*, Fig. 41 (*a*), a circular arc of the required height and length may be drawn in the side view, similar to the arcs *d*, Fig. 41 (*c*). The radius of this arc is $1\frac{1}{2}$ inches. The fillet at the place of junc-

tion of the curved surface of the cover and the flange *a*, Fig. 41 (*a*), is drawn with a radius of $\frac{7}{16}$ inch.

106. Near the cap in the side view of the pillow block, insert the note: *Cap-Pattern No. 10–2*, and near the base: *Base-Pattern No 10–3.* To the same view add the note: *Drill holes* $\frac{15}{16}$*″ and tap for* $\frac{3}{4}$*″ gas pipe;* connect the note by an arrow to one of the lubricating holes. Another note, connected by an arrow to the liner, reads: *Hardwood Liner* $1\frac{9}{32}'' \times \frac{3}{8}'' \times 12''$ *long.* In the side view there should be an overall dimension of $8\frac{5}{8}$ inches from the top face of the cover flange to the bottom line of the base. The note: *No. 1 Babbitt* should be connected by arrows to the babbitt lining in the cap and the base in the half-section of the side view.

As was done in the end view, Fig. 41 (*a*), the term *Spot face* should be connected by an arrow to the top of the right-hand bolt hole in the corresponding assembly view. The term *1″ Core* should be connected by arrows to the holes in the cover and the base, shown in the right-hand half of the end view. The dimensions should be inserted in the manner shown in the sketches, and the finish marks placed wherever required. Finally, the title should be printed as in Fig. 39.

ISOMETRIC AND OBLIQUE PROJECTION DRAWING

ISOMETRIC DRAWING

107. Properties of Perspective Views.—Perspective views have been used in preceding pages to show more clearly the shape and relative positions of machine parts. A perspective view has the advantage over an orthographic projection drawing, commonly called a working drawing, of clearly showing the shape of an object in one view, whereas a working drawing may require two or more views. On the other hand, in a working drawing parallel edges of an object are shown as parallel lines, but not so in a perspective drawing. Besides, in a perspective drawing, the relative sizes of the parts and the distances between them cannot be measured by a uniform scale, as in a working drawing.

108. Substitutes for Perspective Views.—To combine the advantages of a perspective drawing with those of a working drawing, various kinds of drawings are in use. These methods of representing an object, while retaining some of the advantages of a perspective drawing, have the advantage that they may be produced more easily and by means of the instruments used in making an ordinary working drawing. The various methods may be classified as follows: Isometric drawing, oblique projection, and cabinet projection.

109. Principles of Isometric Drawing.—Isometric drawing is particularly adapted to the representation of rectangular solids, the boundary lines of which comprise three sets of parallel lines, each set being at right angles to the other sets. In the drawing, however, the sets of parallel lines used to represent the boundary lines of the solid are not at right angles to one another.

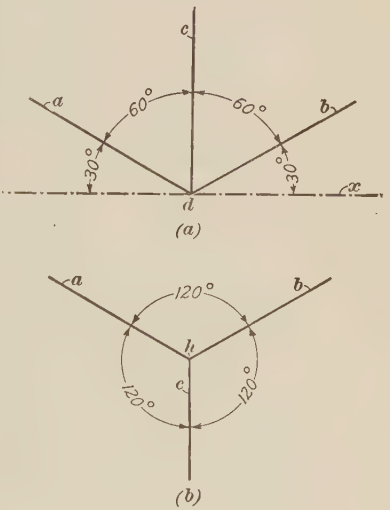


FIG. 43

In Fig. 43 (*a*) is shown the three systems of lines, the lines *a* and *b* being supposed to represent horizontal lines at right angles to each other, and the line *c*, which is vertical, being supposed to represent a line that is at right angles to *a* and *b*. These lines, which meet at the point *d*, are known as *isometric axes*. Lines drawn parallel to these axes are known as isometric lines and may also serve as isometric axes. The term *isometric*, meaning equal measure, is applied to isometric drawing, because any lines drawn parallel to the isometric axes may be measured with the same units of length.

In isometric drawing the axes *a* and *b*, view (*a*), which represent horizontal edges, are set off at an angle of 30° to the

horizontal base line x, consequently these axes make an angle of 60° with the vertical axis c. Or the axis c may be supposed to extend below the base line x, as shown in view (b), in which case the axes intersect at h and make an angle of 120° with one another. The particular advantage derived by using the angles specified is that each angle may be laid off by means of a 30°–60° triangle. It is important to remember that as a result of the basic principles of isometric drawing, only lines drawn parallel to the isometric axes are true to scale.

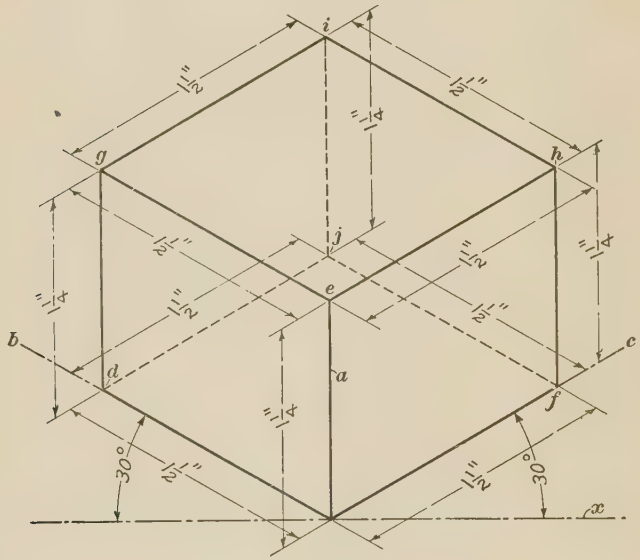


Fig. 44

110. Drawing of Rectangular Objects.—The drawing of a rectangular object is generally started at the point of intersection of the isometric axes chosen for the purpose, sometimes a base line being drawn through this point. Thus, in the diagram, Fig. 43 (a), it may be supposed that the axes a, b, and c, represent three edges of a rectangular object having a corner d on the base line x.

The method of drawing a rectangular object is illustrated in Fig. 44, which represents a rectangular block whose base is

$1\frac{1}{2}$ inches square and whose height is $1\frac{1}{4}$ inches. First, the base line x is drawn, then the vertical axis a, and finally the axes b and c at the required angle to the base line. On the axes b and c distances of $1\frac{1}{2}$ inches are laid off, and on a a distance of $1\frac{1}{4}$ inches, to locate the points d, e, and f. Through the points d and f lines are drawn parallel to the axis a, and through e lines parallel to the axes b and c, respectively, to meet the vertical lines at the points g and h. Then from the points g and h lines are drawn parallel to the axes c and b to meet at i. This completes the drawing of the visible portion

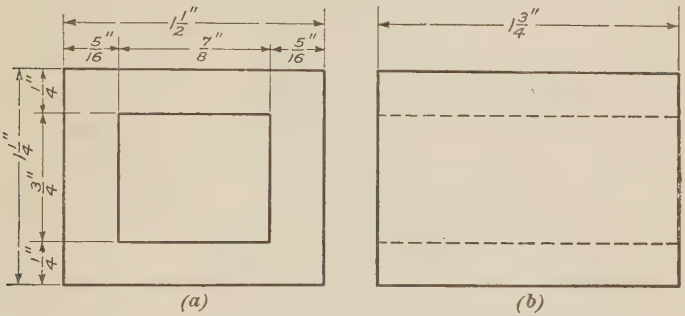


FIG. 45

of the block. To indicate the invisible edges, dotted lines are drawn from the points d, f, and i parallel to the respective axis and meeting at j, as shown. As each edge is parallel to one of the axes, all parts are true to scale, as indicated by the dimensions.

PLATE 1024, TITLE: ISOMETRIC AND OBLIQUE PROJECTION

EXAMPLES OF ISOMETRIC DRAWINGS

111. Rectangular Block With Rectangular Hole.—A working drawing of a hollow, rectangular block is shown in Fig. 45, in which an end view is shown in (a) and a side view in (b). The isometric drawing, Fig. 46, of the block is to be drawn as Fig. 1 on the drawing plate. Locate the point b, Fig. 46, at a distance of $2\frac{1}{4}$ inches from the left-hand border line and 4 inches below the top border line. From the point b draw the lines c and d at an angle of 30° to the base line. The lines a, c, and d

will then be the isometric axes on which the drawing is to be constructed. On a lay off a distance be equal to the height of the block, or $1\frac{1}{4}$ inches; on c lay off a distance bf equal to the width, or $1\frac{1}{2}$ inches; and on d a distance bg equal to the length, or $1\frac{3}{4}$ inches. From f and g draw lines parallel to the axis a; from e draw a line parallel to the axis c to intersect at h the vertical line from f; from e draw also a line parallel to the

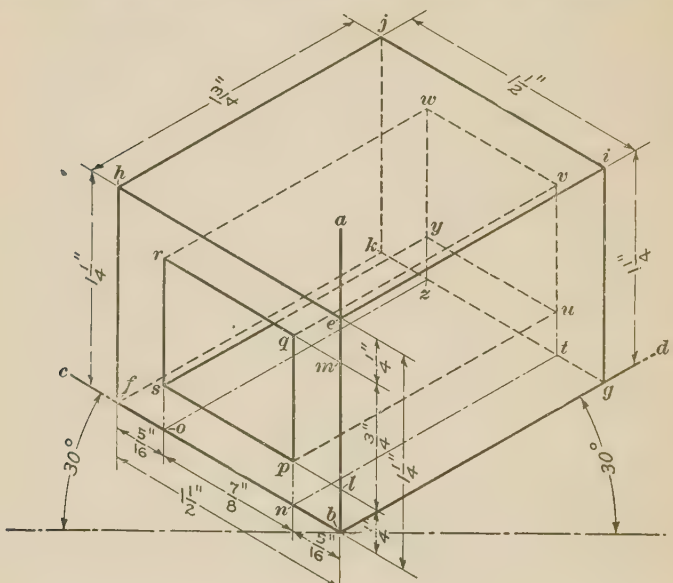


FIG. 46

axis d to intersect at i the vertical line from g. Next, draw from h and i lines parallel to the axes d and c, respectively, to meet in the point j. Finally, draw dotted lines from the points f, g, and j parallel to the axes d, c, and a, respectively, to meet at the point k. This completes the drawing of the block except the hole.

112. The hole through the block, Fig. 46, is located in the following manner: Lay off on the axis a the distances bl and bm equal to $\frac{1}{4}$ inch and 1 inch, respectively. Next, lay off on the axis c the distances bn and bo equal to $\frac{5}{16}$ inch and

$1\frac{3}{16}$ inches, respectively. From the points l and m draw lines parallel to the axis c, and from n and o lines parallel to the axis a, these lines intersecting in the points p, q, r, and s, as shown. The rectangle $pqrs$ is the front end of the rectangular hole. Indicate the corners of the hole by drawing lines parallel to the axis d from the points p, q, r, and s. To locate the rear end of the hole, draw lines from the points n and o parallel to the axis d to intersect the line gk in the points t and z. From the latter points draw lines parallel to the axis a to intersect the lines from p and q in the points u and v, and the lines from r and s in the points w and y, respectively. Draw the lines vw

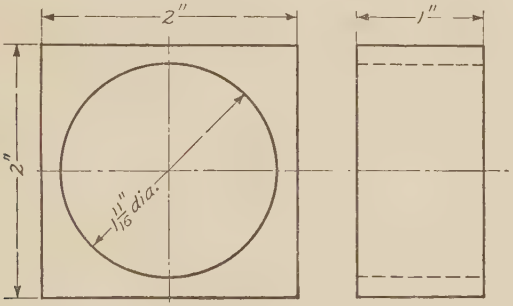


Fig. 47

and uy to complete the rear end of the hole; these lines will be parallel to the axis c. The front end of the hole, as well as the visible portion of the line sy, must be drawn in full lines. The hidden edges of the block and the hidden corners of the hole must be shown in dotted lines. The dimension lines and the dimensions are added in the manner shown. Usually, the extension lines are drawn as extensions of the edges to which they refer. The reference letters used in the text illustrations are not to be placed on any of the views made on the drawing plate.

113. Rectangular Block With Circular Hole.—The working drawing, Fig. 47, represents a rectangular block with a circular hole. This block is to be shown in an isometric drawing as Fig. 2 (a) on the drawing plate. The method to

be followed in making this drawing is illustrated in Fig. 48 (*a*), (*b*), and (*c*). In beginning to draw Fig. 2 (*a*) on the plate, locate the point *a*, Fig. 48 (*a*), 6 inches from the right-hand border line, and 4 inches below the top border line. From *a* draw the vertical axis *b*; then the axes *c* and *d* at an angle of 30° to the base line *x*. On the axes *b* and *c* lay off, according to Fig. 48 (*a*), the points *e* and *f* at a distance of 2 inches from the point *a*, and from the points *e* and *f* draw lines parallel to the axes *c* and *b*, respectively, to meet at *g*. Lay off on the axis *d* the distance *ah* equal to 1 inch, the thickness of the block,

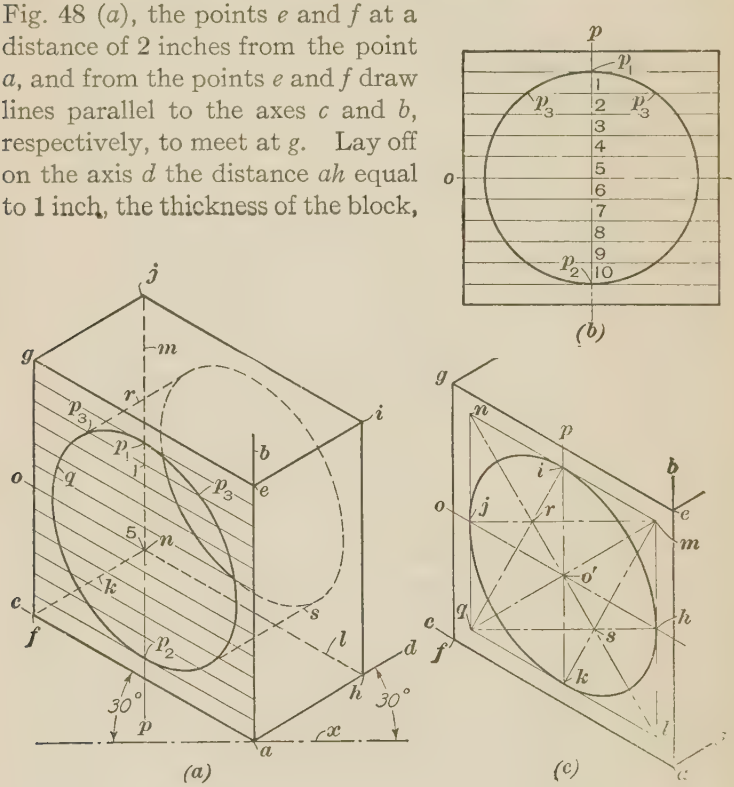


Fig. 48

and from *h* draw a line parallel to the axis *b* to meet at *i* a line drawn from *e* parallel to the axis *d*. From *i* and *g* draw lines parallel to the axes *c* and *d*, respectively, to meet in the point *j*. On drawing the dotted lines *k*, *l*, and *m* parallel to their respective axes and meeting at *n*, the drawing of the block, without the hole, is complete.

114. In Fig. 48 (*a*) the circular hole in the block appears to be elliptical. Draw the front end of this hole by means of the method known as *plotting*. This method consists in locating a sufficient number of points on the ellipse and connecting them by an irregular curve. To obtain the positions of these points, it is necessary to make a front view of the block corresponding with that shown in Fig. 48 (*b*). This view is to be designated as Fig. 2 (*b*) on the plate. Extend the base line *x* of Fig. 2 (*a*) to the left, and $6\frac{1}{2}$ inches from the left-hand border line, lay off on this line a point to locate the position of the center line *p*, Fig. 48 (*b*). Draw this center line; then, at a distance of 1 inch above the base line draw the horizontal center line *o*. Complete the front view of the block and use the point of intersection of the center lines *o* and *p* as a center for describing a circle with a diameter of $1\frac{11}{16}$ inches. Divide the vertical diameter p_1 p_2 into a number of equal parts, in this case 10, and through the points of division, p_1, *1*, *2*, etc., draw horizontal lines across the view. If greater accuracy is required, the diameter is divided into a greater number of parts.

115. The construction made in Fig. 2 (*b*) must now be transferred to Fig. 2 (*a*). For this purpose lay off from the point *a*, as in Fig. 48 (*a*), a distance of 1 inch on the axes *b* and *c* and through the points obtained draw the center lines *o* and *p*, respectively. From the point *5*, where these center lines intersect, lay off on *p*, on both sides of the point *5*, the radius p_1, *5*, view (*b*), to obtain the diameter p_1 p_2 in view (*a*). On this diameter set off the points of division made in view (*b*); then through these points draw lines parallel to the axis *c*. In Fig. 2 (*b*) the lines through p_1 and p_2 intersect the line *p* in points where these lines are tangent to the circle. Hence, the corresponding points in view (*a*) are points on the circle. To obtain other points, ascertain from Fig. 2 (*b*) the position of points on the circle where it intersects the horizontal lines. For instance, the line drawn through the point *1* intersects the circle in the points p_3. Set the dividers to the distance p_3 *1* and lay off this distance on both sides of the center line *p*,

Fig. 2 (*a*), from the point *1* on the line drawn through this point, thus obtaining the points p_3. The numbers *2*, *3*, etc. are omitted from Fig. 2 (*a*) to avoid confusion. Other points in Fig. 2 (*b*) where the circle intersects the horizontal lines are located in a similar manner. Through the points thus obtained in Fig. 2 (*a*) on the lines corresponding with those drawn through the points *1* to *10*, view (*b*), draw the curve *q*, which represents a circle in the isometric drawing. It will be noted that the curve is an ellipse.

The rear end of the circular hole is drawn in the same manner inside the square *hijn*. The greater portion of this ellipse will not be visible from the front and the hidden portion is to be shown in dotted lines. The dotted lines *r* and *s*, drawn parallel to the axis *d* and tangent to the two ellipses, represent the sides of the hole. The method of plotting, here shown, may be used for making an isometric drawing of any irregular figure or curve.

116. A simple, approximate method of drawing the ellipses representing the circular ends of the hole is to be shown in Fig. 2 (*c*) on the plate, in accordance with the method shown in Fig. 48 (*c*). On the plate locate the point *a*, Fig. 48 (*c*), 2 inches from the right-hand border line, and 4 inches below the top border line. From this point draw the isometric axes *b*, *c*, and *d*; construct the front face *aegf* of the block and draw the center lines *o* and *p*, as in Fig. 2 (*a*). The point *o'* in which the center lines intersect will be the center of the front end of the hole.

Lay off on these center lines the points *h*, *i*, *j*, and *k* at a distance from the center *o'* equal to the radius of the hole, or $\frac{27}{32}$ inch. In these points the circular end of the hole crosses the center lines. Draw light lines through these points, parallel to the axes *b* and *c*, respectively, as shown, to form a quadrilateral, which represents the square in which the circular end of the hole is inscribed. Draw the diagonal *ln* and from the points *m* and *q* draw the lines *mj*, *mk*, and *qh*, *qi*, respectively, to the middle points of the opposite sides. These lines cross the diagonal *ln* at *r* and *s*. With *r* as center and *ri* as

radius draw the arc *ij*, and with *s* as center and the radius *sh* draw the arc *hk*. Then, with *m* as center and the radius *jm* draw the arc *jk*, and with *q* as center and the radius *qh* draw the arc *hi*. The resulting ellipse is generally found sufficiently accurate. The other end of the hole may be drawn in the same manner.

117. Irregular Shapes.—An end view and a side view of a block having an irregular cross-section, are shown in Fig. 49 (*a*) and (*b*), respectively. An isometric drawing of this block is to be made as Fig. **3** (*b*) on the plate. As none of the sides in the end view, Fig. 49 (*a*), is parallel to any of the isometric

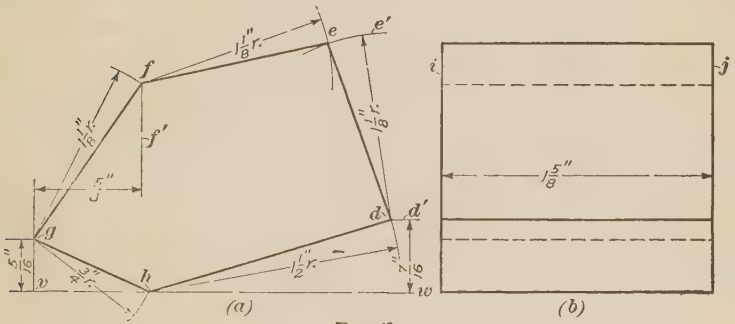


FIG. 49

axes, it is necessary to use the plotting method in making the isometric drawing.

To serve as a basis for the isometric drawing, it is necessary to redraw Fig. 49 (*a*) on the plate as Fig. **3** (*a*). In beginning the drawing on the plate locate the point *g*, Fig. 49 (*a*), at a distance of $\frac{5}{8}$ inch from the left-hand border line and $5\frac{7}{8}$ inches above the bottom border line. After this cross-section is completed, it is necessary to draw a vertical and a horizontal axis, as in Fig. 50 (*a*), to serve as a basis for the isometric drawing. While these axes may be drawn at any convenient distance from the cross-section, on the plate the axis *ab* is conveniently drawn at a distance of $\frac{5}{16}$ inch below the point *h*, and the axis *ac* at a distance of $\frac{1}{4}$ inch from the point *d*. In the manner shown in Fig. 50 (*a*) connect each corner of the

cross-section by a vertical and a horizontal line with the axes *ab* and *ac*.

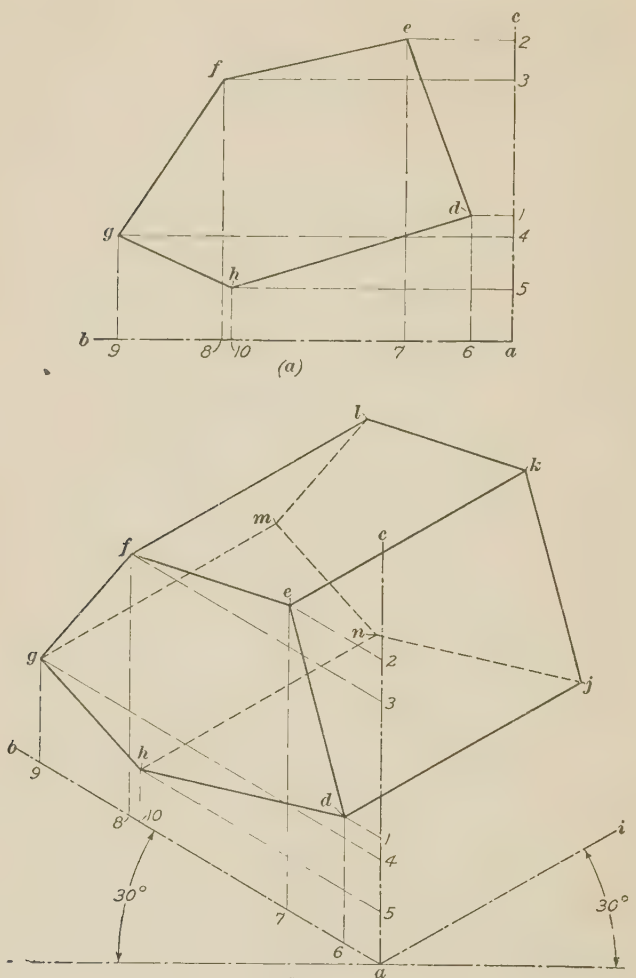


FIG. 50

118. Begin the isometric drawing, Fig. 3 (*b*), by locating the point *a*, Fig. 50 (*b*), at a distance of $6\frac{1}{8}$ inches from the left-hand border line and 5 inches above the lower border line. From *a* draw the two axes *b* and *i* at 30° with the base line;

then draw the vertical axis *c*. The axes *b* and *c* correspond, respectively, with the lines *ab* and *ac*, Fig. 50 (*a*).

The method followed in drawing Fig. **3** (*b*) on the plate is illustrated in Fig. 50 (*b*). Thus, lay off from the point *a* on the axis *c* the distances *a1*, *a2*, *a3*, *a4*, and *a5*, as obtained from Fig. **3** (*a*). In the same manner lay off on the axis *b* from the point *a* the distances *a6*, *a7*, etc. From the points laid off on the axis *b* draw light lines parallel to the axis *c*, and from the points laid off on the axis *c* draw lines parallel to the axis *b*. Where the lines from points *1* and *6* intersect, the point *d* is located; similarly, where the lines from points *2* and *7* intersect, the point *e* is located. Points *f*, *g*, and *h* are located in the same manner Connect these points by lines to obtain the outline of the front face.

119. To obtain the other faces of the block, Fig. **3** (*b*), draw, as in Fig. 50 (*b*), from the points *d*, *e*, *f*, *g*, and *h* lines of indefinite length parallel to the axis *i*. On the line drawn from *d*, lay off a distance of $1\frac{5}{8}$ inches, equal to the length of the block, thus locating the point *j* From *j* draw a line parallel to *de* to meet at *k* the line drawn from *e*. Continue in the same manner to locate the points *l*, *m*, and *n*. Connect these points by lines to obtain the outline of the rear face of the block. The hidden edges are represented by dotted lines.

OBLIQUE PROJECTION

120. Principles of Oblique Projection.—In oblique projection one face, chosen as the front face of the object, is drawn as in an ordinary shop drawing; that is, if rectangular, it is shown as such and with its sides drawn to scale. For instance, the square face *afge* of the rectangular block, Fig. 53, is shown as a square with sides of equal length. The edges of the faces that are at right angles to this face are, however, represented by lines drawn at any desired angle with the horizontal; but, preferably, at an angle of 45°. The relative positions of the three axes used in oblique projection are shown in Fig. 51, where *a* is the point of intersection of the axes *b* and *c*, drawn at right angles to each other. The axis *d* is drawn at an angle of 45° with the horizontal, or base, line *x*.

121. Rectangular Block With Circular Hole.—The working drawing, Fig. 52, shows an end view (*a*) and a side view (*b*) of a rectangular block with a circular hole. The oblique projection, Fig. 53, of the block is to be drawn as Fig. **4** on the drawing plate, where the point *a*, Fig. 53, is located at a distance of $6\frac{3}{8}$ inches from the right-hand border line and 5 inches above the bottom border line. From *a* draw the vertical axis *b*, and the horizontal axis *c*. The axis *d* is drawn at an angle of 45° with an extension of the axis *c*. On the axis *b* lay off the point *e* 2 inches above *a*, and on the axis *c* lay off the point *f* 2 inches from *a*. From *e* and *f* draw lines parallel to the axes *c* and *b*, respectively, the lines meeting at *g*. As the center of the front end of the circular hole in the block lies at the center of the front face, the center of the latter must be located. Its position is found by laying off from point *a* 1 inch on the axes *b* and *c*, thus obtaining the center points *h*

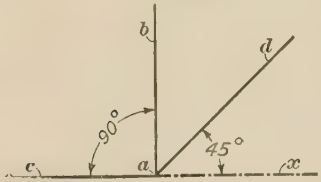


FIG. 51

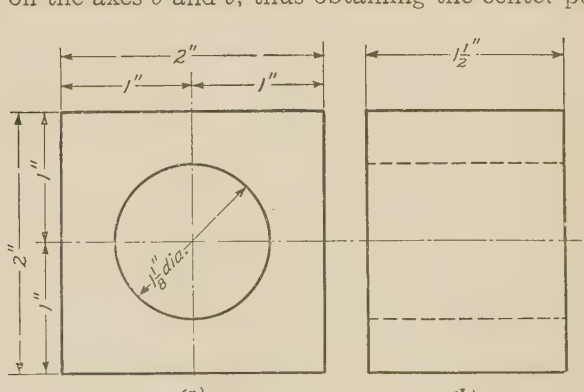


FIG. 52

and *i* of the sides *af* and *ac*. Draw a horizontal line from *h*, and a vertical line from *b*, then the point of intersection *j* is the required center.

122. Continue the oblique projection, Fig. **4**, by drawing from the points *e*, *f*, and *g*, Fig. 53, lines of indefinite length,

parallel to the axis d. On d lay off the distance al equal to $1\frac{1}{2}$

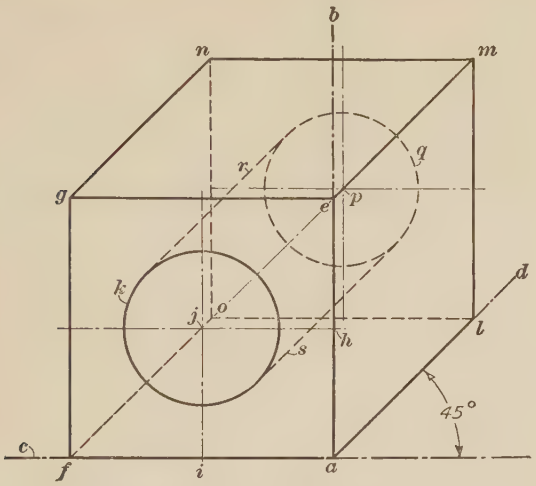


FIG. 53

inches, to show the thickness of the block. From l draw a vertical to meet at m the line drawn from e. From m draw a horizontal to meet at n the line drawn from g, and from n draw a vertical line to meet at o the line drawn from f. Join the points c and l by a horizontal line.

To locate the center p of the far end of the hole, repeat the construction shown at the front end, or simply draw from the center j, a line parallel to the axis d and from j lay off the distance jp equal to al; then p is the required center from which the circle q is drawn with a radius of $\frac{9}{16}$ inch. Draw the lines r and s tangent to the circles to represent the sides of the hole. It is seen that all lines in this drawing

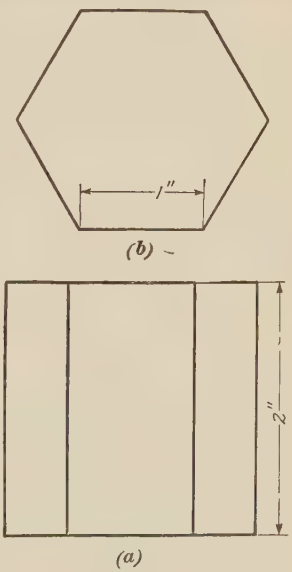


FIG. 54

may be drawn with a **T** square, a 45° triangle, and compasses, and that the construction is simpler than that of an isometric drawing. As in other drawings, the hidden edges are indicated by dotted lines.

123. Hexagonal Block.—The working drawing, Fig. 54, shows a side view (*a*), and a plan view (*b*) of a hexagonal block 2 inches high; the sides in the plan are 1 inch long. The oblique projection, to be made as Fig. **5** on the drawing plate, is shown in Fig. 55. On the drawing plate locate the point *b*,

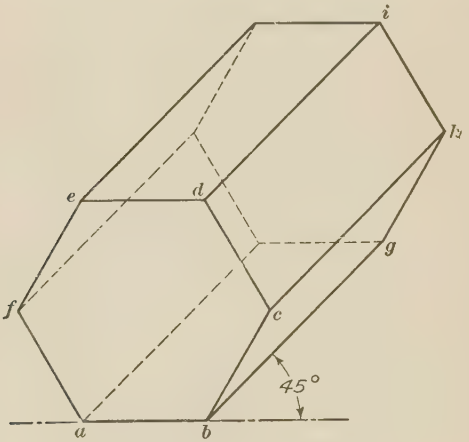


FIG. 55

Fig. 55, $2\frac{1}{2}$ inches from the right-hand border line, and 5 inches above the bottom border line. Make the side *ab* 1 inch long and on this side construct the hexagon *abcdef* in the usual manner by inscribing it in a circle of 1-inch radius. From the corners of the hexagon draw lines of indefinite length at 45° to the base line, and on the line from *b* lay off the point *g* 2 inches from *b* to represent the length of the block. From *g* draw a line *gh* parallel to *bc* to meet in *h* the line from *c*. Draw the remaining sides of the hexagon, representing the far end of the block, parallel to corresponding sides in the front face. The various lines in this projection may be drawn with a **T** square, a 45°, and a 60° triangle.

124. Angle Plate With V Notch.—The working drawing, Fig. 56, shows a front view (*a*) and an end view (*b*) of an angle

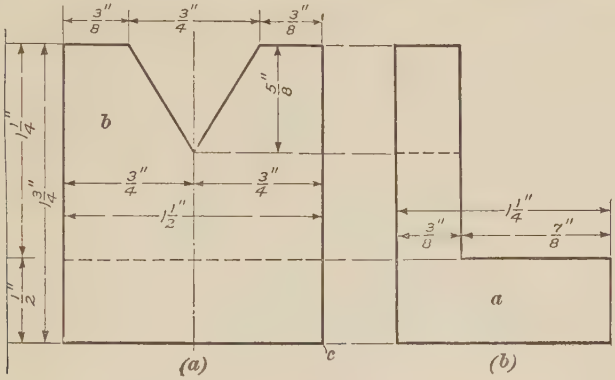


FIG 56

plate with a V notch in the vertical leg. An oblique projection drawing similar to Fig. 57 is to be made, in which an end face is turned to the front, thus occupying a position corresponding with that of *a* in Fig 56 (*b*). On the drawing plate, where the angle plate is to be drawn as Fig. 6 locate the point corresponding to the point *a*, Fig. 57, at a distance of $\frac{3}{4}$ inch from the left-hand border line, and $1\frac{1}{4}$ inches above the bottom border line. Make the line *ab* $1\frac{1}{4}$ inches long and draw the end face *abcdef* according to the dimensions given in Fig. 56; then from the points *a*, *b*, *c*, *d*, *e*, and *f* draw lines of indefinite length at an angle of 45° with the

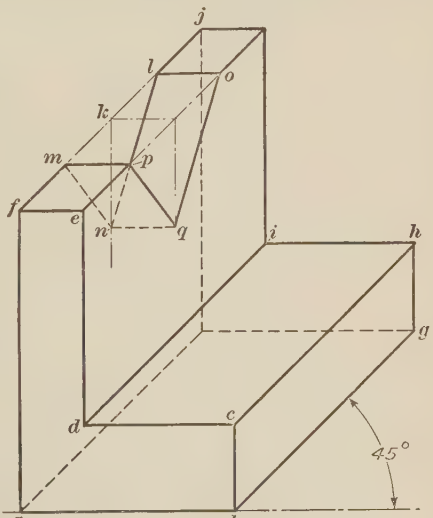


FIG. 57

base line. On the line from b lay off bg equal to $1\frac{1}{2}$ inches. From g draw a vertical line to meet at h the line from c. Draw the horizontal line hi to meet at i the line from d. Draw the remaining edges on the far end parallel to the corresponding edges on the front end.

125. It is seen from Fig. 56 (a) that the **V** notch is $\frac{3}{4}$ inch wide at the top and $\frac{5}{8}$ inch deep. As its center line coincides with that of the face b, it is necessary to locate the latter center line. Therefore, lay off the point k, Fig. 57, $\frac{3}{4}$ inch from f and draw a vertical line from k. Lay off on the line fj $\frac{3}{8}$ inch on each side of k to locate the points l and m, and $\frac{5}{8}$ inch below k lay off the bottom point n of the notch. Draw the lines ln and mn, and from l and m draw horizontal lines to meet in o and p the line drawn from e. From o and p draw lines parallel to ln and mn, respectively, to meet at q. Draw the line nq, which will be horizontal.

126. As an additional example in oblique projection, draw the angle plate in a position corresponding with that shown in Fig. 56 (a), in which the face b is in front. On the plate locate the point c, Fig. 56 (a), 6 inches from the left-hand border line and $1\frac{1}{4}$ inches above the bottom border line. For this view, which represents Fig. **7** on the drawing plate, no illustration is given in the text to aid its construction, as the method to be followed corresponds with that used in Fig. 57.

127. Bracket.—The working drawing, Fig. 58, shows in view (a) an end view of a bracket with a rectangular base a and a vertical lug b with a circular hole. The lug b has vertical end faces of which the front one is shown at c. View (b), which is a side view of the bracket, shows that the lug b is equidistant from the ends of the base a.

The oblique projection, Fig. 59, of the bracket is to be drawn on Plate 1024 as Fig. **8.** On the plate locate the point d, Fig. 59, $6\frac{1}{4}$ inches from the right-hand border line, and $1\frac{1}{4}$ inches above the bottom border line. Draw the rectangular base a to the dimensions given in Fig. 58, and so that an end face is turned to the front, as in Fig. 58 (a).

The lug *b* being centrally located on the base, it is necessary to draw the center line *fg*, Fig. 59. Therefore, lay off the

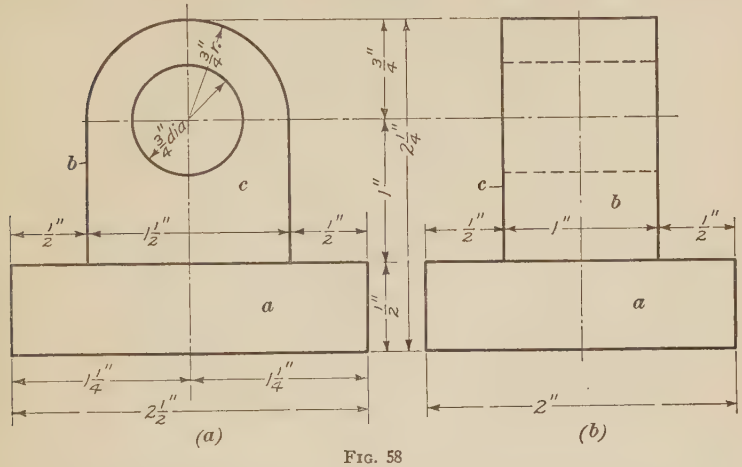


FIG. 58

point *f* $1\frac{1}{4}$ inches from one end of the edge *e* and draw the center line *fg* at an angle of 45° to the edge *e*. The front face *c* of the lug and the corresponding rear face being at the same

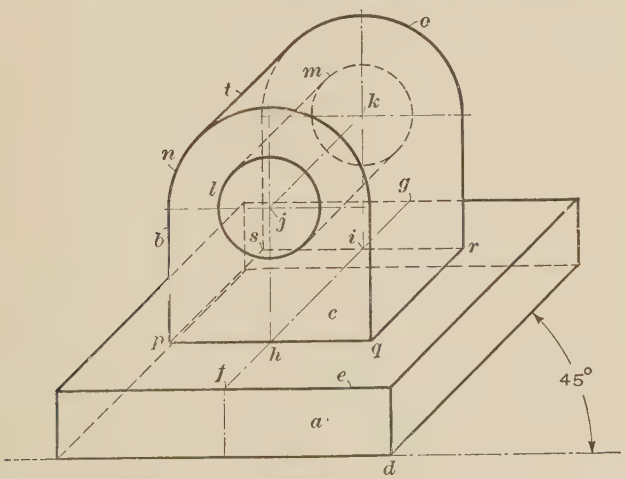


FIG. 59

distance from the points *f* and *g*, respectively, lay off each of the distances *fh* and *gi* equal to $\frac{1}{2}$ inch. The vertical lines

drawn from *h* and *i* will be the center lines of the front and the rear face of the lug. On the front center line lay off the center *j* 1 inch from *h* and draw the center line *jk* of the hole. Then, with *j* and *k* as centers and a radius of $\frac{3}{8}$ inch draw the circles *l* and *m*, as the front and the rear edge of the hole. With the same centers and a radius of $\frac{3}{4}$ inch draw the semicircles *n* and *o*.

Next, draw horizontal lines through the points *h* and *i* and vertical lines tangent to the semicircles *n* and *o* to meet the horizontal lines, just drawn, in *p*, *q*, *r*, and *s*. Draw the lines *ps* and *qr*, and draw the line *t* tangent to the semicircles *n* and *o*. Invisible edges and corners are indicated by dotted lines.

Print the figure numbers under the various views, and lay off, as usual, a space in the lower right-hand corner to contain the title *Isometric and Oblique Projection.*

128. Cabinet Projection.—In a variation of oblique projection, known as *cabinet projection*, the edges of the faces that are at right angles to the front face are drawn one-half their true length to reduce the seeming distortion of the object. Thus, in Fig. 53 the lines *al*, *em*, and *gn* would each be made only $\frac{3}{4}$ inch long, instead of $1\frac{1}{2}$ inches, as in oblique projection.